

Freeman Graham



FIG. A.—Showing contrast of sarcoma tissues and normal tissues as affected by radium.



FIG. B.—Sarcoma of lower end of femur after amputation.
See page 46.

INTERNATIONAL CLINICS

A QUARTERLY

OF

ILLUSTRATED CLINICAL LECTURES AND
ESPECIALLY PREPARED ORIGINAL ARTICLES

ON

TREATMENT, MEDICINE, SURGERY, NEUROLOGY, PÆDIAT-
RICS, OBSTETRICS, GYNÆCOLOGY, ORTHOPÆDICS,
PATHOLOGY, DERMATOLOGY, OPHTHALMOLOGY,
OTOLOGY, RHINOLOGY, LARYNGOLOGY,
HYGIENE, AND OTHER TOPICS OF INTEREST
TO STUDENTS AND PRACTITIONERS

BY LEADING MEMBERS OF THE MEDICAL PROFESSION
THROUGHOUT THE WORLD

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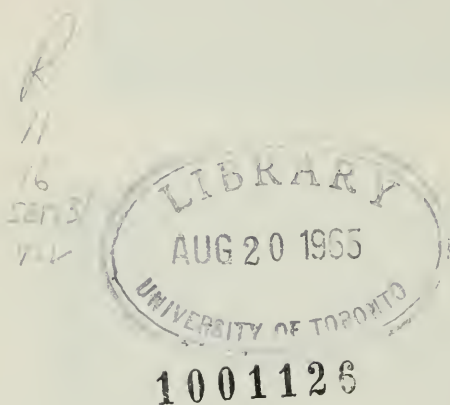
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Clinics

DIAGNOSIS OF HEART DISEASES

LECTURE TO THE POST GRADUATE CLASS, PRESBYTERIAN HOSPITAL, JANUARY 19, 1921

By JAMES E. TALLEY, M.D.

Philadelphia

A CAREFUL history and complete physical examination are important in cardiac diagnosis. The close relationship between the rheumatic group and heart disease is well recognized. Acute rheumatic fever, chorea, tonsillitis, so-called growing pains in children, may all be forerunners of cardiac involvement. The insidiousness of rheumatic affections in childhood cannot be too strongly emphasized. Scarlet fever, puerperal sepsis, and syphilis may all be causative factors, the latter showing itself often only in the fourth and fifth decades, though the primary infection was many years before. In pneumonia and typhoid fever there may be either direct involvement or the toxæmia may unmask an already impaired heart. Erysipelas, carbuncles, and even furunculosis, though less common, are not negligible in the possibility of causing more widespread infections. Recently we have had a patient under observation with diaphragmatic pleurisy ending in a localized empyema, where the only recent focus of infection was boils. Again, following immediately upon a large carbuncle, a patient first showed evidence of nephritis, which still persists after some five years. Remembering the tendency of acute endocardial trouble to recur and to involve the myocardium, and that the bacteriology of acute rheumatic fever is still a mooted question, focal infections should receive our careful attention. Teeth, tonsils, ears, sinuses, the prostate, and the pelvic organs should all be considered. The injurious effect of diphtheria upon the heart is well known. By graphic methods myocardial involvement may be shown to exist even when the child has seemed to recover, and it is this late persistence which makes prolonged rest a

necessity after diphtheria. In diphtheria and in angina pectoris there is often fatty degeneration, but this is a pathologic diagnosis. Fatty heart is not a clinical diagnosis we should make. Endocrine gland disturbance may have a decided deleterious influence on the heart, as is shown in hyperthyroidism. In marked arterial sclerosis, essential hypertension, and contracted kidney the heart is not sound. No heart working against persistent high blood-pressure, 160 in young adults, 180 in the aged, can remain unimpaired.

ENLARGED HEART

A permanently enlarged heart is a diseased heart. Definite enlargement of the heart may be due to hypertrophy, increase in its muscular mass; or dilatation, that is, stretching of its walls or enlargement of its cavities. Contrast to yourselves the hypertrophy found in old aortic insufficiency and contracted kidney, and the dilatation occurring in a few hours or days in paroxysmal tachycardia of some duration. In chronically enlarged hearts varying degrees of hypertrophy and dilatation usually co-exist. Attempts at determining the relative value of these two elements are unnecessary in chronic heart disease; the determination of fixed enlargement suffices.

MEANS OF DETERMINING THE SIZE OF THE HEART

The size of the heart in normal individuals varies with their body weight, age, sex, circumference of chest, and position of the body. Strong muscular development means a larger heart for the individual than in one of soft fibre. The closest and most permanent correlation is between the body weight and weight of the heart. All clinical methods of estimating the size of the heart are only approximate. The orthodiagraphic method in the hands of the well trained is one of the most exact methods we possess. The only objections to it are special apparatus, special skill, the time consumed and the uncertainty of working with a mobile organ. Claytor and Merrill ¹ studied men in the vertical position with the orthodiagraph comparing the weight of the patients with the transverse diameter of the heart's shadow. In men from 109 to 117 pounds the average transverse diameter was practically 11 centimetres. It rose gradually with each increment of practically 10 pounds in weight to 13 centimetres in men from 163 to 181 pounds. The Teleröntgenogram is exact and

quick. The picture of the heart is taken with the tube two metres from the patient to minimize optical distortion of the rays. With exposures made at twenty-eight inches one centimetre should be deducted from the greatest transverse diameter of the heart shadow to make it correspond with the true or long distance silhouette. Le Wald² finds the greatest normal transverse diameter from thirteen to fourteen centimetres (five and one-eighth to five and a half inches), exposure made at a distance of twenty-eight inches. In the long distance exposure, he finds the apex point from the median line is eight centimetres (three and one-eighth inches) in the average normal individual. Likewise, if the right border is three centimetres (one and one-quarter inches) from the median line, it corresponded to the average sized individual. Bardeen³ has investigated the size and weight of the heart in large groups of normal children and adults. Some of his deductions are, that the most accurate size of the heart is the square surface of the Teleröntgenogram. This is quickly estimated by the planimeter; he finds that there is a constant relationship between body weight and the size of the heart; he points out that the transverse diameters of the heart and the great vessels are the most objective obtainable. For the sake of simplicity clinicians and Röntgenologists largely confine themselves to these diameters in interpreting X-ray silhouettes. The following facts are culled from Bardeen's paper. In infants of normal weight at birth the greatest transverse diameter of the heart shadow is 5 centimetres. At one year it has increased to 7 centimetres. From one year to fourteen years it gradually rises to 11 centimetres, which is the adult lower level. In a normal adult of 100 pounds, the greatest transverse diameter of the long distance shadow is 11 centimetres. Increasing parallel with increasing weight, it rises to 15 centimetres at 200 pounds. From 200 to 300 pounds it slowly attains a maximum of 16.5 centimetres. If one's general impression be true that the majority of normal people will vary somewhere between 120 and 180 pounds, then 12 to 14 centimetres would be satisfactory numbers to bear in mind as representing the variations in the normal transverse diameter in the Teleröntgenogram. In X-ray silhouettes in cardiovascular subjects we must also study the great vessels. Here again the transverse diameter is probably the most useful index. For reference I will add the table of Vaquez and Bordet.⁴

TABLE OF THREE DIMENSIONS

BY

VAQUEZ AND BORDET

Normal Subjects. Men		Standing Position	
Age	Transverse diameter in cm.	Chord of aortic arch in cm.	Diameter of ascending aorta in cm.
16 to 20 years	4 to 5	0 to 2.5	1.5 to 2
20 to 30 years	5	2.5	2
30 to 40 years	5 to 6	2.5 to 3.3	2 to 2.5
40 to 50 years	5.5 to 7	2.8 to 3.5	2.5 to 2.8
50 to 60 years	6 to 7	3 to 3.7	2.5 to 3
Over 60 years	6 to 8	3 to 4	3

In this table the transverse diameter is that of the arch of the aorta, and means the maximal distance which separates the contours of the aortic shadow on the right and left of the sternum. The chord of the aortic arch means "that part of the arch where it issues from the mediastinal shadow and begins its outline on the left pulmonary field to its intersection with the pulmonary artery below." Let us emphasize again that since the size of the heart varies with weight, age, sex, muscular development, and position of the body, whether upright, sitting, or prone, also in systole and diastole, X-ray silhouettes are approximate. However, with the systematization of methods, more accurate deductions are drawn than formerly. One of the greatest stumbling blocks to the adoption of a uniform method is the difficulty of position. Many patients cannot stand erect long enough for taking the X-ray shadow, and in the recumbent position the heart is larger, and the difficulty of placing the tube 6 feet from the patient is greater. However, this striving for a quantitative standard gives more exact information than our old general impressions. It will interest you to know in passing that the reason the heart is smaller in the standing than in the recumbent position is due to the changes of hydrostatic pressure in the inferior vena cava. From these mechanical methods of estimating the size of the heart, we will turn to our old methods of inspection, palpation, percussion, and auscultation.

APEX BEAT OR MAXIMAL IMPULSE

The normal impulse is a sustained thrust, definitely palpable, in the fifth interspace, 3 to 4½ inches from the median line of the sternum, and is confined to a small area. Lewis says the outermost

part of the circumscribed area is our best clinical guide to the left border of the heart. It corresponds with the left limit of the orthodiagraphic silhouette in normal hearts or those but moderately enlarged. In greatly enlarged hearts it is a guide to the size, but not to its left border.

The mid-sternal line is the most accurate point from which to measure the apex beat and the borders of the heart.

Distance mid-sternal line to maximum apex beat:

(1) Ordinarily given, $3\frac{1}{2}$ to 4 inches (9 to 10 cm.).

(2) Lewis⁵ gives 3 to 4.5 inches (roughly 7.5 to 11.5 cm.).

Goodman,⁶ studying recruits by inspection, palpation, percussion and auscultation, concludes that the size of the heart varies directly with the weight and chest measurement of the individual. Thus, according to his tables, from mid-sternum to the left border of the heart averages 8 cm. in men of 110 pounds, rising gradually with increase in weight to 11 cm. at 200 pounds. Again from mid-sternum to left border was 8 cm. in men with chest circumference of 30 inches, rising gradually to 11 cm. with chest circumference of 39 inches. These figures bear out the statement of Lewis that the usual 3.5 inches (9 cm.) from mid-sternum to maximal impulse is not elastic enough.

A definite maximal impulse lying more than 4.5 inches to the left of the mid-sternal line is direct evidence of enlargement of the heart, especially if it lies in the sixth interspace.

Percussion.—Define the left cardiac border by percussing from the axilla inward, compare with the outermost limit of the apex beat. To percuss the right border, find the upper level of liver dullness, percuss inward just above this. Definite cardiac dullness to the right of the sternum means displaced heart or engorged right auricle.

Cardiac Murmurs.—The most fruitful use of auscultation is in detecting cardiac murmurs. Though systolic murmurs are more common, detection of a diastolic murmur is decisive evidence of heart disease.

A diastolic murmur at the base, usually in the second interspace to the right of the sternum, often in the second left interspace, transmitted down the borders of the sternum to the apex beat, is a sign of *aortic regurgitation*. In early cases the murmur is frequently heard to the left. In young adults rheumatic fever is a common cause, in middle life syphilis. Anæmia is frequently marked. Further diag-

nosis rests upon the water-hammer pulse, throbbing carotids, capillary pulsation, as seen beneath the nails after pressure, on the forehead after stroking, or in the retracted lower lip. Duroziez's systolic thud or shock or double murmur may be heard in the brachial or femoral arteries. Evidences of enlarged heart are usually present. Since experimental aortic incompetence produces some evidence of hypertrophy in a month, aortic regurgitation in man probably gives rise to some early hypertrophy. Blood-pressure studies afford valuable evidence. The great divergence between systolic and diastolic pressure in the arm is suggestive. Thus the normal average pulse pressure of 40 to 50 may be doubled. More striking is the marked difference between the systolic pressure in the arm and in the leg in aortic incompetency. The systolic pressure in the leg is much higher than in the arm. In the leg the divergence between systolic and diastolic pressure is more marked, so that the pulse pressure in the leg may be double the high values found in the arm. The polygram is characteristic. Its ascent is high, top sharp, its drop quick, with a poorly developed dicrotic notch and wave. The electrocardiogram usually but not always gives evidence of left-sided preponderance.

Mitral Stenosis.—Stenosis of the mitral valve is a common sequel of rheumatism, chorea, repeated tonsillitis, and scarlet fever. The infection is not confined to the valve alone, but invades the myocardium, causing a progressive myocarditis. It is the commonest lesion associated with auricular fibrillation, especially among young adults. The stasis in the auricles with both regular and irregular rhythms leads to comparatively frequent thrombosis. Hence the rather common embolism in this disease. It is the lesion most commonly associated with hæmoptysis. Goodman⁷ has stressed the impairment of resonance of the apex of the left lung in mitral stenosis. This impairment, especially if associated with hæmoptysis, suggests pulmonary tuberculosis, whereas the pressure due to a dilated left auricle is probably the cause of the dulness. Aphonia is not uncommon in these cases, due to pressure by the enlarged left auricle upon the left recurrent laryngeal nerve, as demonstrated by Norris and Fetterolf. In long-standing cases there may be some clubbing of the fingers, slight flushing or cyanosis of cheeks and lips with a background slightly icteric. The apex beat is more often in its normal position. The amount of hypertrophy is not apt to displace the apex outward and

downward. A thrill is of diagnostic value only if it is clearly diastolic in time and has a genuine purr. Percussion as well as X-ray will show the "mitral" shadow, broad in its transverse diameter, especially in the auricular region. Auscultation is the most helpful means of diagnosis in mitral stenosis. A diastolic murmur at the apex means organic heart disease—usually mitral stenosis. Occasionally further study may show this diastolic murmur originates at the aortic area. The diastolic murmur of mitral stenosis may be early or mid-diastolic, and may or may not be associated with a pre-systolic element. Again, this murmur may begin soon after the second sound and run throughout the diastole.

The pre-systolic murmur may be absent where earlier murmurs are present and the pulse is regular. Again with the onset of auricular fibrillation, the pre-systolic murmur disappears, and the earlier diastolic murmurs persist. Even in well-marked cases of stenosis the diastolic murmur may not be heard on first examination, especially with the patient in the upright position. In patients with a history of rheumatism, especially if they have a mitral systolic murmur masking the first sound, a careful search should be made for stenosis. This murmur is heard best with the patient lying on the left side, especially after exercise. Hopping twenty-five times on one foot, and then twenty-five times on the other, will bring out the murmur, particularly in the left lateral position. The exercise increases the velocity of the blood current through the stenosed valve, and thus increases the audibility of the murmur. Nitrite of amyl is said to have the same effect. The murmur of mitral stenosis is low pitched, sometimes described as a rumble. It is heard best at the apex or just at the inner side of the apex. White⁸ finds that these low-pitched murmurs are best heard with the plain bell attachment of the stethoscope, whereas he prefers the diaphragm ear-piece for the aortic regurgitant murmurs. In mitral stenosis the first sound is usually described as sharp and snappy. Sometimes it shows a duplication. The second sounds, especially pulmonary, may be accentuated, they may be doubled. They serve only to suggest, especially in the presence of a history of rheumatism, the desirability of seeking out the murmurs of mitral stenosis. The electrocardiogram may show auricular hypertrophy; that is, a P wave over 3 mm. in height, or over one-tenth second in duration. Also, there may be evidence of right

ventricular preponderance. If these changes are present in the electrocardiogram, we may be reasonably sure of mitral stenosis. Their absence proves nothing. Naturally, in fibrillation, there is no P wave. A few points on differential diagnosis must be added. To most observers the Graham Steell murmur has always appeared uncommon. Others appeared to find it quite common. It is a high-pitched, diastolic murmur, heard best at the third left costal cartilage. It is supposed to be due to functional regurgitation through the pulmonary valve because of increased pressure in the pulmonary artery. Its time, position and quality are those of the murmur of aortic regurgitation. The distinction rests upon the well-known symptoms and signs of aortic insufficiency.

Aortic regurgitation with the Flint murmur at the apex may be difficult to diagnose from organic mitral stenosis. The Flint murmur has been called the murmur of functional mitral stenosis. It is caused by the current of blood entering the left ventricle from the left auricle through a mitral valve, narrowed by the impingement on its anterior cusp of the regurgitant flow descending from the aortic valve. Since it may occur in any stage of diastole, and may be accompanied by a thrill, and some find it a common concomitant of aortic regurgitation, one must consider the collateral signs and symptoms in making a differential diagnosis. In mitral stenosis the apex impulse is a sharp tap with quick withdrawal, in aortic regurgitation, a powerful heave with slow recoil. In mitral stenosis the pulse is small, the pulse pressure is normal or low, whereas in aortic regurgitation the pulse is Corrigan in type and the pulse pressure is high. In X-ray there is the "mitral" shape as contrasted with the longer diameter of aortic regurgitation. In the electrocardiogram right-sided preponderance speaks for stenosis, left ventricular preponderance for aortic regurgitation. The diastolic murmur of aortic regurgitation is transmitted along the borders of the sternum, is higher pitched and runs throughout diastole. White emphasizes the fact that in mitral stenosis the murmur commences at a definite interval after the second sound.

Systolic Murmurs.—Though systolic murmurs are far commoner, they are decidedly less helpful in diagnosing organic heart disease. The commonest is the cardio-respiratory murmur, heard at the apex, over the precordium, or even at the angle of the left scapula. It is of short duration, high pitched, and heard best during inspiration.

It disappears when the breath is held, as it is probably a breath sound rather than a murmur. It is of no importance. The next commonest systolic murmur is heard at the pulmonary cartilage, especially when the patient is recumbent. It may also be heard at the apex. Unlike the systolic murmur of pulmonary stenosis, it is inconstant, does not show the transmission along the clavicle, is not accompanied by a thrill in the region of the pulmonary cartilage, and there is no history of cyanosis in the patient.

Aortic Systolic Murmurs.—An aortic systolic murmur extremely rarely means aortic stenosis. Ordinarily it means stiffening of the valves, roughening of the intima of the aorta, or some abnormal hæmic state. Especially in men past middle life with dilatation of the ascending aorta, the aortic systolic murmur may be harsh or musical. But the ringing second sound differentiates it from stenosis. In the rare genuine aortic stenosis a thrill of the greatest intensity is found at the base of the heart. A rough systolic murmur with maximum intensity at the aortic cartilage is transmitted to the great vessels. The pulse tracing is flat topped. Commonly, aortic stenosis is associated with some aortic incompetence. The important thing to bear in mind is that an aortic systolic murmur but seldom means aortic stenosis.

Tri-cuspid Systolic Murmurs.—Their maximum intensity is in the ensiform region. They may be provoked by strenuous exercise. In cardiac failure a systolic pulsation in, and engorgement of the veins of the neck, are more important than the murmur.

Mitral Systolic Murmurs.—Formerly a systolic murmur heard with maximum intensity at the apex and transmitted into the axilla was considered diagnostic of mitral incompetence. Clinical, combined with post-mortem experience, has shown this conception to be often fallacious. Murmurs of exactly the same character may accompany a distorted valve, a lax ring and no demonstrable lesion with almost equal frequency. Mitral systolic murmurs which are constant from day to day suggest an organic basis. A mitral systolic murmur in a patient with a history of rheumatism in the last ten years should make one try to find a diastolic murmur in this patient, using all the means described under mitral stenosis to bring out the diastolic murmur.

A mitral systolic murmur suggests the use of exercise tests to test

out cardiac competence. A mitral systolic murmur due to genuine mitral disease should lead to some auricular hypertrophy and right-sided preponderance which may be present in the electrocardiogram. Their presence is confirmatory, but their absence means little, as the amount of hypertrophy of the heart in mitral disease is small.

During your course we have fully considered the differentiation of cardiac arrhythmias by both graphic and simple methods. Let us review the latter briefly, studying cardiac rhythm and rate, especially at the apex.

Sinus Arrhythmia.—Sinus arrhythmia is a condition found in children and young adults. It is closely connected with respiration, the pulse-rate increasing during inspiration and decreasing during expiration. This form of arrhythmia may be exaggerated by deep breathing, and is abolished by anything which increases the pulse-rate, as exercise or fever. It is rarely found with a pulse-rate of 120 or above.

A *premature beat or extra systole* may be recognized by its early appearance, by a pause which is compensatory or short of it, by the weakness of the heart sounds—sometimes the second sound being absent—and by the weakness or absence of the radial pulse. They are more commonly present when the pulse is at the ordinary rate, and the patient is upright. They are abolished by anything like exercise which increases the pulse-rate. Ordinarily being wiped out by a rate of 120 to 140, they are prone to show themselves in the period following exercise and after a period of holding the breath. More often graphic methods are necessary to differentiate auricular from ventricular premature beats.

Heart Block.—Simple prolongation of conduction is usually accurately demonstrated only by exact methods. In the grade of heart block where there is an occasional, or regularly recurring dropped beat, the irregularity is to be differentiated from premature beat thus: On listening at the apex, instead of a premature beat, one will find silence over the heart almost twice as long as the normal interval. A regular pulse-rate of 50 may be bradycardia, but it suggests block. A regular pulse-rate of 40 suggests 2 to 1 heart block. In complete block the ventricular rate is usually 30. It may be less, occasionally it is more, especially when the impulse arises high up in the bundle.

Two to one heart block may be difficult to differentiate from a slow normal rhythm, but 2 to 1 heart block is an unstable condition. Sudden halving or doubling of the pulse is suspicious. Again in 2 to 1 heart block by means of posture, exercise, or atropine, we may be able to change the grade of the block or abolish it. Higher grades of block, as 3 to 1 and 4 to 1, are still more unstable and tend to pass into complete block.

Paroxysmal Tachycardia.—A regular apex rate of 150 and above, uninfluenced by any change in posture of the patient, and unassociated with any of the usual toxæmias causing simple tachycardia, especially if there is a subjective history on the part of the patient of the onset and offset, tends to fix this condition as of the paroxysmal variety.

Auricular Flutter.—You have seen curves where the patient with a regular rate of 75 shows, when examined graphically, that there was an auricular rate of 300, and there was 4 to 1 block. This illustrates the difficulty of saying that your patient has flutter unless he is examined by exact methods. However, there are some differences which point to the diagnosis between paroxysmal tachycardia and auricular flutter. Auricular flutter when once established is apt to be a permanent condition. Tachycardia, on the other hand, comes in spells, as its name implies.

The rate in auricular flutter is more easily influenced by position, exercise, and drugs than in paroxysmal tachycardia. The reaction of the two abnormal mechanisms to digitalis is interesting. You have seen curves of a man who with auricular flutter seven years ago was given digitalis, which produced auricular fibrillation, and to-day he is still fibrillating. In paroxysmal tachycardia, on the other hand, digitalis never slows the rate, but it sometimes seems to help abolish the paroxysm.

Alternation is characterized by alternate stronger and weaker heart beats. It shows best in a sphygmogram.

Where alternation is a permanent feature, it can be demonstrated by the sphygmomanometer.

Adjust the apparatus as if you were taking blood-pressure. Near the point of systolic pressure, either every other beat comes through as a weak one, or fails to be heard until you have lowered the mercury in the column some 20 or 30 mm.

Auricular Fibrillation.—A persistent irregular rhythm of the

heart, with a pulse-rate of 100 or above, is almost always auricular fibrillation. It is the maximal irregularity of the heart, and once established it is permanent. At the apex one hears a jumble of loud and weak sounds with varying pauses. The count at the apex and the count at the radial do not agree or often do not—there is a pulse deficit. In slower fibrillation with a pulse around 80, there may be difficulty in differentiating this irregularity from extra-systolic arrhythmia. Exercise the patient, and when you raise the rate to 120 or above, the arrhythmia of auricular fibrillation increases, the other disappears.

After exercise the irregularity of auricular fibrillation grows less with fall of pulse-rate, but the irregularity of extra-systolic arrhythmia increases with fall in pulse-rate.

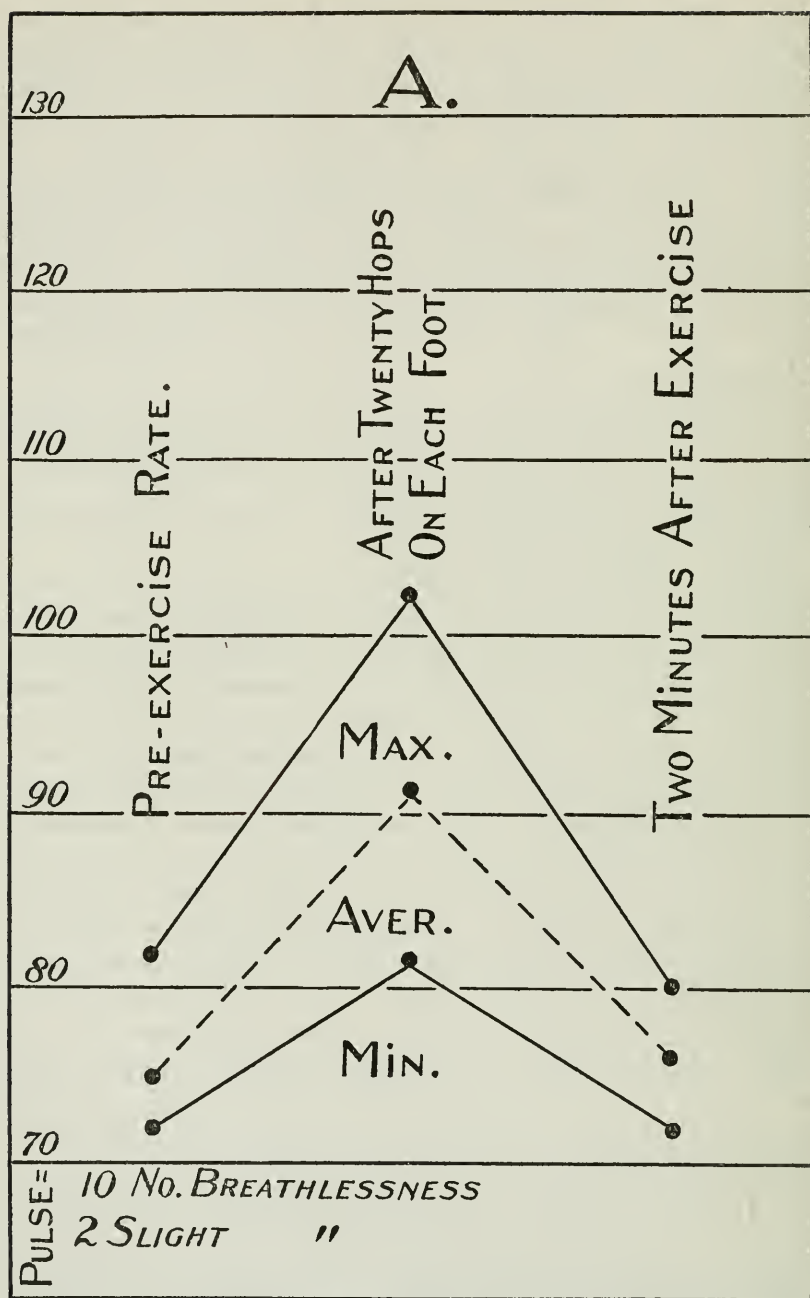
Chronic Myocarditis.—Though in disfavor for sometime, this term owes its revival to the insight into the changes of myocardial function afforded us by the newer instruments of precision. Chronic myocardial disease may be diagnosed where the heart is definitely and permanently enlarged. We have seen the curves of a patient whose arrhythmia was due to recurring premature contractions, both auricular and ventricular. In this patient the enlarged heart was due to essential hypertension. The same is true in the heart enlarged secondary to contracted kidney. In auricular fibrillation, auricular flutter, heart block, and alternation, chronic myocarditis exists. In well-established aortic incompetence, even if simply rheumatic in origin, there is an invasion of the myocardium; where the aortic lesion is luetic, there is not only involvement of the myocardium and the valves, but of the proximal portion of the aorta which contains the beginning of the coronary arteries. The same chronic myocarditis exists in well-established mitral stenosis, for about half these cases develop auricular fibrillation. The majority of patients with aneurism die not of rupture but of heart failure, again pointing to an unsound myocardium.

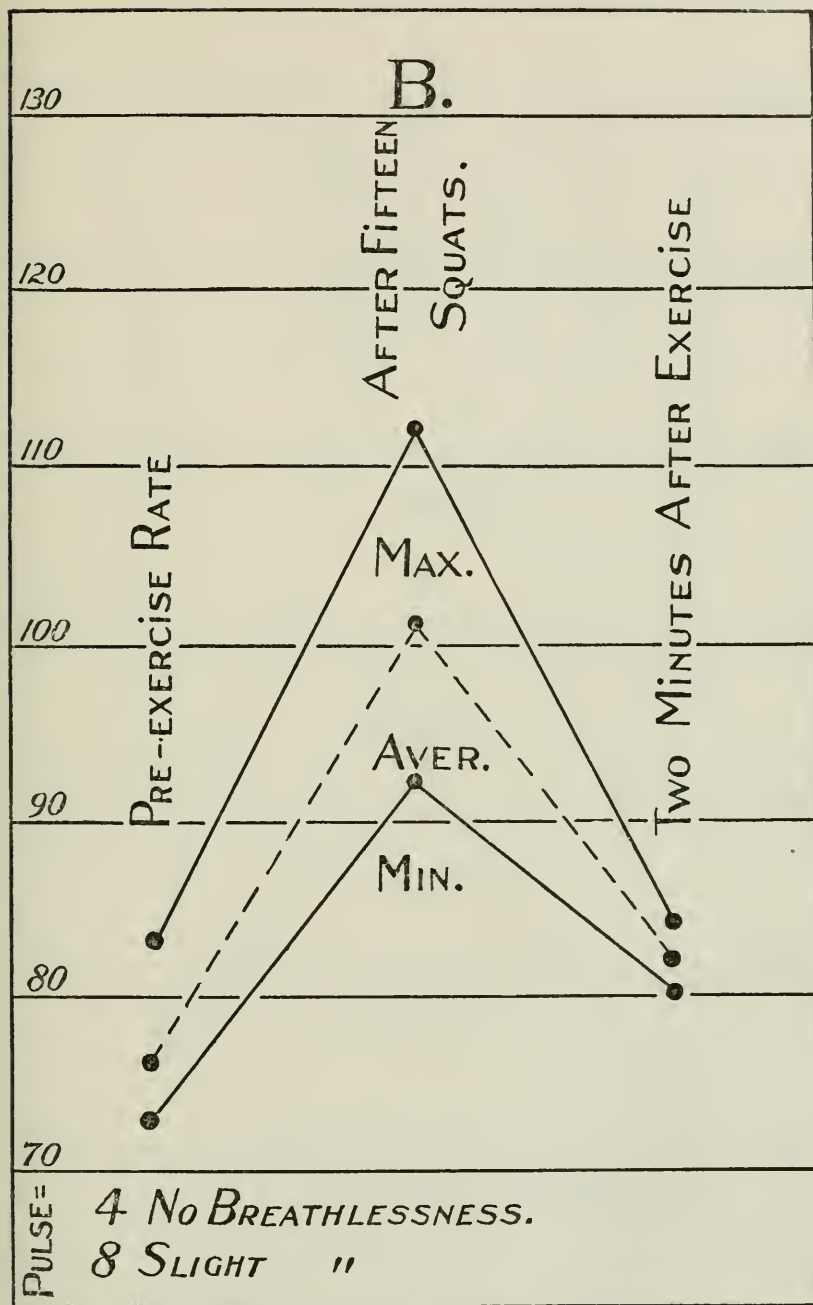
In genuine angina pectoris you may have an enlarged heart or a heart that appears normal in size and function. In this disease there is degeneration not only of muscles but of the coronary arteries. Heretofore, with our attention focussed upon valve lesions and the supposed connection between these lesions and hypertrophy and dilatation, books were filled with the words compensation and decompensation.

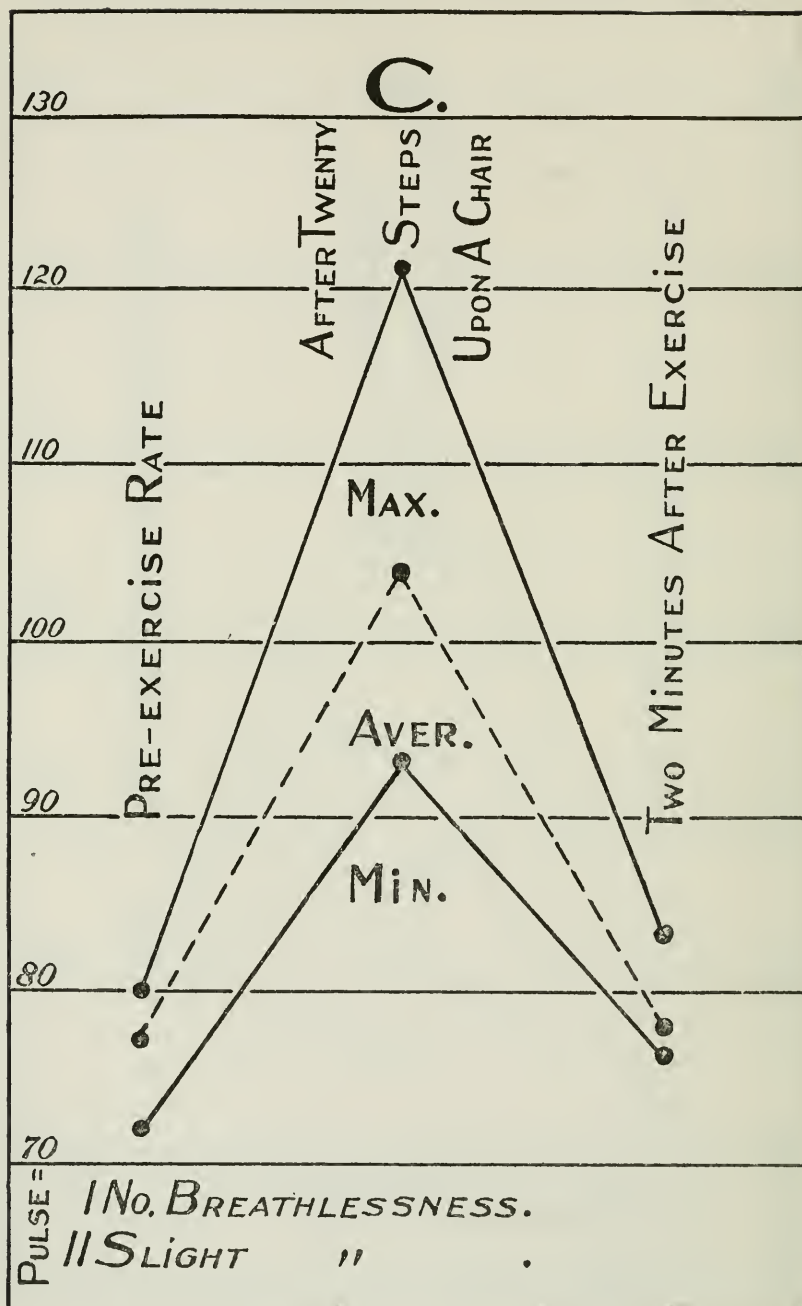
sation. More recently we have learned that sound ventricles mean efficient circulation. A heart muscle weakened by disease, by poison, or by overwork, fails to function just like any other muscle under similar conditions. This inability longer to meet the usual demands made upon it leads to heart failure with congestion or heart failure with angina. First, the patient notices easy fatigue; second, some dyspnœa on ordinary exertion, and then pain. In heart failure with congestion following the symptoms enumerated come engorgement of the veins of the neck, which means engorgement of the right heart, soon enlargement of the liver, crepitant râles at the base of the lungs, dropsy and cyanosis.

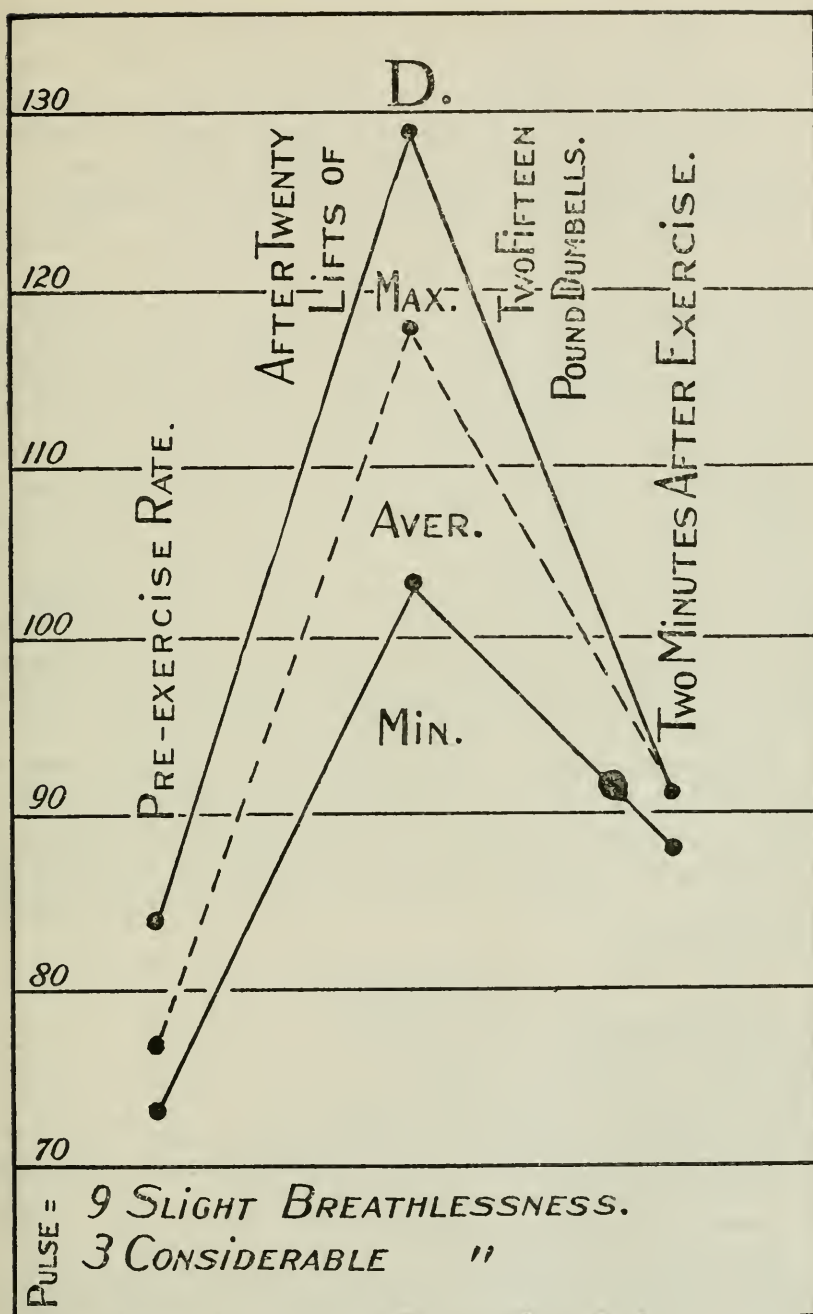
Genuine *angina pectoris* is a disease of middle or advanced life. It is usually provoked by some unusual exercise. The more definitely the pain is sub-sternal in the beginning, the more apt it is to be the genuine variety. Alternation of the pulse and signs of organic heart disease are often but not always present.

Tests of Heart Function.—There is no satisfactory method of estimating cardiac function, though many have been suggested. Those of you interested may read Barton's⁹ and Kahn's¹⁰ summaries. The responses of heart rate to changes in posture, to simple graded exercises, such as stair-climbing, hopping on each foot alternately, squatting, raising one's self on a chair, raising dumb-bells, give a definite reaction in cardiac rate. This reaction should not be excessive, and should return to the normal in two minutes in the normal heart. Dr. William D. Stroud has kindly allowed me to include the observations he made upon twelve young, healthy adults. His object was to find their responses to varying grades of exercise. The same men were put through the four exercises. In each table maximum is the individual who gave the widest response, minimum is the individual who gave the least response, average is an average of the twelve. Thus in Table A, the average pulse-rate before exercise was 75; after twenty hops on each foot it rose to 91, and in two minutes had fallen to 76. In Table B the average pulse-rate before exercise was 76, rising to 101 after fifteen squats, and falling to 82 in two minutes. In Table C the average pulse-rate before exercise rose from 77 to 104 after twenty steps upon a chair, falling to the original starting point two minutes after exercise. In Table D, before exercise, the pulse-rate was 77; after twenty lifts of two fifteen-









pound dumb-bells the pulse-rate was 118, and fell to 91 in two minutes. These tables illustrate an ascending grade of severity of exercise, which may be useful in trying to force out the diastolic murmur of mitral stenosis as well as testing the heart's reaction. They further illustrate a very important point, and that is the desirability of studying the effect on the individual as well as on his pulse-rate. So that you will see that Doctor Stroud has found that the number showing breathlessness after the varying degrees of exercise increases in proportion to the severity of the exercise. In stepping upon the chair, the man places his foot squarely upon the chair and raises himself to a full erect position the twenty times. The dumb-bells are raised from the floor to the full length of the arms above the head at the rate of one lift in two seconds. The average increases in rate in Stroud's tables were after twenty hops on each foot 16, with return to normal in two minutes. After fifteen squats were 25, with almost a return to normal in two minutes. After the chair test were 27, with return to normal. In the dumb-bell test were 41, with a pulse fifteen points above normal at the end of two minutes. In patients with impaired hearts there will be a sharper reaction in rate, slower return to normal level, and the breathlessness and distress will be in excess of that found in a normal individual for the given exercise.

The heart beats more slowly by from seven to fifteen beats in the recumbent than in the erect position. This difference is diminished or altogether lost in cases of incompetent valvular disease, or when the heart is seriously weakened. The normal increase from recumbency to a standing position should not be more than twenty beats per minute.

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STRICTURE OF THE ŒSOPHAGUS

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CLINIC AT THE PHILADELPHIA GENERAL HOSPITAL

CASE I.—The first case has an interesting and puzzling clinical history. It states that the patient is sixty-four years of age, male, white, married, and born in Ireland. He was admitted on the 18th of October, complaining of cough, sleeplessness and poor appetite; not the ordinary signs of Blockley patients, dyspnœa and weakness, but you will note that both were present. In February of this year, 1920, he had an attack of influenza after which a cough remained that has become gradually worse. Two weeks ago he had difficulty in breathing, more marked if lying on the back; and he has not slept well since. During the past few days he has coughed a great deal and has become more dyspnœic. He has little pain and very little expectoration. He has never noticed blood in the sputum. He coughs a little more in the morning than at other times, but the appearance of the expectoration is not different then. His appetite has been poor for the last two weeks. The bowels are in good condition. There is no history of circulatory, urinary or digestive symptoms. There has been no swelling of the legs or ankles. He has lost five pounds in three weeks.

Previous History.—He had some sort of fever when twenty-nine years of age, which left him crippled for some time. There is no history of rheumatism, scarlet fever, pneumonia, typhoid fever, chorea or tonsillitis. He had influenza in 1919 and in February, 1920. He denies venereal history entirely. His wife is living and has melancholia. Three sons and one daughter are living and well and three daughters are dead, one of whom is said to have died of tuberculosis. The patient is a laborer, but did no heavy work. He lived under good conditions. Formerly he drank to excess. He smoked moderately and drank coffee moderately. He was not exposed to dust.

The history only indicates some trouble in the chest, apparently a

severe condition, which is associated with much pain, a severe cough, and very little expectoration.

Physical Examination.—The patient is a clean, cadaverous, white adult male. There is no gross abnormality in posture, gait or station; no headache; no jaundice. He is emaciated, and the skin hangs about him very loosely. He has a dusky, cyanotic tinge. The sclera is subicteroid; he is clear mentally; and there is no eruption on the skin. The breath is extremely offensive. During coughing the patient becomes very dyspnoëic. The pupils are rather small. They react rather sluggishly to light, and not at all to accommodation. This would be a sort of reversed Argyl-Robertson pupil, but it probably is an error in observation. There is no paralysis, nystagmus, ptosis or hippus. His mouth is in a frightful condition—all stumps, pyorrhœa and gingivitis. No adenopathy; no tracheal tug; no deviation; no thyroid enlargement or vascular pulsation. The chest is rather emphysematous in shape. The infra- and supra-clavicular fossæ are deep; no adenopathies about the clavicles. The expansion of the chest is free. The left side is said to lag slightly behind the right. The diaphragm on the right side moves normally, but its movement on the left cannot be determined. The description of the signs in the thorax is confusing. As nearly as I can determine the conditions are as follows:

The costal margins do not move freely during respiration. The ribs and interspaces are prominent. At both apices anteriorly and posteriorly the breath sounds are normal. Vocal and tactile fremitus are normal on the left side anteriorly above the third rib. Below this point they are diminished and occasionally a coarse râle is heard. Posteriorly on the right side the percussion note, vocal and tactile fremitus are normal. A coarse whistling râle is heard occasionally at the apex. On the left side the note is dull at the apex to a point $4\frac{1}{2}$ cm. below the vertebra prominens. It is impaired for a further distance of 7 cm., and again dull below this line. The impairment of the note extends 8 cm. from the spine to the left, and beyond this it is again dull for a distance of 23 cm. from the spine.

It is rather difficult to understand what is meant by this. Apparently in the upper part of the lung there is dulness. Below this there is impairment, which extends as far as 8 cm. to the left of the spine; and then dulness replaces the impairment. Then the dulness ex-

tends 23 cm. from the spine. Altogether that would be fifteen centimetres from the place where it begins. In front of this it becomes normal again. I assume that by dulness is meant a less resonant note than by impairment.

"The coin test is negative. The whispered voice sounds are not increased on the left side. Occasional coarse râles are heard."

"Blood-pressure 115 and 65. Left border of the heart $10\frac{1}{2}$ cm.; right border 2 cm. from the median line, a total of $12\frac{1}{2}$ cm. (which is not an enlargement). The apex beat could not be located. No murmur; no arrhythmia; no evidence of loss of muscle tone. The second pulmonic sound is accentuated."

"Abdomen normal in all respects; genitalia normal in all respects. Reflexes all prompt and equal; no abnormal reflex. Some sclerosis of the radial and brachial arteries."

A tentative diagnosis was made at this time of a bronchiectatic cavity of the left lung.

"Blood count: Red cells, 3,489,000; white cells, 13,400. Anæmia with leucocytosis. Neutrophils, 73; lymphocytes, 22; evidence of infection."

"A specimen of urine contained a trace of albumen; no acetone, but hyaline and granular casts. The phenolsulphonphthalein test; first hour 20 per cent., second hour no record, probably reduced."

"The sputum has a necrotic odor and is seropurulent. There are no elastic fibres; no tubercle bacilli, but an enormous number of leucocytes." Evidently pus was being formed in the lung. Nothing was found in the two examinations of the nose and throat, although there was a little congestion of the vocal cords, and Doctor Husik notes that there is a suspicion of tuberculosis. Altogether two examinations of the sputum were made with identical results.

The patient suffered intensely the night of admission from dyspnoea. He became orthopneic about eight o'clock and was obliged to sit up in a chair all night.

On the following day, "he had a constant harrassing, brassy cough, usually unproductive. There is an extremely foul odor to the breath, resembling *Bacillus Pyocyaneus*. The pupils are contracted; the right is larger than the left. There is little response to light in either. The right carotid artery is a little larger than the left. (This may be an anomaly or due to unequal distribution of arteriosclerosis.)

There is a doubtful tracheal tug. The supracardiac note is dull in both second and third interspaces. The heart sounds are distant. A faint systolic murmur is heard at the pulmonic cartilage. There is generalized emphysema, very poor expansion and distinct impairment of percussion note at the left apex posteriorly. A few non-persistent râles are heard over the left lower lobe. There is change in the voice sounds." This has changed somewhat since three days ago, when there were numerous râles. A well-advanced sclerosis of the radial and brachial arteries and tortuosity of the brachials is also noted. Blood-pressure is 120 and 70.

The diagnosis recorded at this time is "an old tuberculous lesion of the left apex; some mediastinal involvement; possibly an aneurism; bronchitis of the left lower lobe, or possibly bronchiectasis. The signs in the left base are perhaps due to obstruction of the entrance of air." The Wassermann was negative. The urine was normal and on another examination alkaline in reaction. The man still has persistent orthopnoea.

On the 22nd an X-ray picture of the lung was made showing a lesion at each base with marked fibrous change, and the röntgenologist regarded the significance of the findings as uncertain.

Inhalations of compound tincture of benzoin were given with relief. On the 23rd, the percussion note was higher in pitch at the right than at the left apex. This is the only percussion note change. No significant change in the voice, breath sounds, vocal or tactile fremitus, anteriorly, right or left. Posteriorly, the percussion note is dull almost down to the angle of the scapula. Tactile and vocal fremitus are of equal intensity right and left. Percussion resonant on the right. There is no change in the breath sounds. No râles are audible. The patient complains of some pain in the left anterior axillary line below the level of the nipple on respiration.

On the 23rd this note was made. For the following reasons the diagnosis of broncho-pneumonia, superadded to whatever basic pulmonary condition may be present, must be considered; first, because of the rapid increase in the symptoms observed two weeks ago with increasing dyspnoea; second, the temperature curve since admission; third, leucocytosis; fourth, the variability in the signs; fifth, the X-ray plate.

He complained on the 23rd of precordial pain during respiration,

situated underneath or just below the left nipple. His condition was worse. "He sleeps poorly and is markedly orthopneic. The blood-pressure is coming down." "He still complains of pain in the precordium and is markedly weaker." The pulse became intermittent about 9 A.M., and in spite of stimulation he died at 1.15 P.M.

A necropsy was obtained. A culture was made from the sputum of the 22nd and it was found to contain a non-hæmolytic streptococcus.

The temperature chart in this case is rather startling. You notice that from the time he came in he had an intermittent fever—a good deal more fever than intermission. Only three times did it go below normal. He had a rapid pulse, but a pulse that was probably not more rapid than it should have been for the amount of fever; and he had respirations ranging from 42 to about 20, but most of the time quite high; that is, his dyspnoea was nearly constant.

Let me recapitulate briefly: This man had some febrile disease with very irregular temperature line. He had a dry cough of a most intense type. He had severe pain in the chest, and he had progressive weakness. He had also dulness in the left apex. This dulness was the only definite physical sign that persisted in the three physical examinations that were carefully made; and it was not associated, apparently, with any change in the transmission of the voice; that is, as far as the examination went the right lung was normal. There were a few sibilant and senorous râles heard, but apparently at no time any subcrepitant râles.

If one can speak of anything as the cause of death (which is unlikely, because we do not know why people die, but only that they do), it would be a fair assumption in this case to suppose that he died of some cardiac complication; because before his death his heart became irregular and his pulse intermittent, which means that there were probably numerous extra systoles, not transmitted to the radial pulse; and in a few hours in spite of stimulation he died.

Of course, that type of death is not particularly characteristic. It may occur in any condition. A non-hæmolytic streptococcus may or may not be the cause of the man's infection. Has anyone any suggestions to make concerning the case? What do you think it is?

Answer: Pulmonary abscess.

Doctor Sailer: Why?

Answer: Both the temperature and the leucocyte count.

Doctor Sailer: He had fever and a leucocytosis, and he has one other thing that may be mentioned.

Answer: The physical findings.

Doctor Sailer: Yes, but more than that. Have we any evidence of pus being formed in the lung?

Answer: The sputum.

Doctor Sailer: Yes. A pulmonary abscess may have ruptured into a bronchus. There is only one thing against that view. Can you think of it?

No answer.

Doctor Sailer: How about the quantity of the sputum? There was hardly enough to lead one to suspect that a pulmonary abscess had ruptured into a bronchus. Has anyone else any suggestion to make? What else could this man have had? In the notes of this case there are two diagnoses made: a bronchiectatic cavity and a broncho-pneumonia.

Answer: He may have had a tuberculous lesion at the apex and perhaps gangrene at the base.

Doctor Sailer: I am glad you brought that out. It is important. What is there in favor of a tuberculous lesion in the apex?

Answer: A little dulness and some râles.

Doctor Sailer: There was something the matter with the apex of this man's lung. We do not know what it was; but we always suspect tuberculosis in such cases. What evidence is there in favor of gangrene?

Answer: Fetid sputum.

Doctor Sailer: That is pretty good evidence. What is there against gangrene?

No reply.

Doctor Sailer: What should there have been if the man had gangrene?

No reply.

Doctor Sailer: A white shadow in the X-ray plate because gangrene shows a good shadow. But they did not notice a shadow and I think that they would have done so if there had been extensive or even moderate gangrene. That does not exclude this diagnosis. What about broncho-pneumonia? What is the evidence for it?

Answer: That the lung was involved on the left side rather than the right side or that the lesion was bilateral.

Doctor Sailer: The clinicians who observed the case give a number of reasons. The evidence of infection, common to all pneumonias, does not help much. They speak of the shifting of signs. As a matter of fact, the signs did not shift a great deal. In the first description we had dulness above and dulness on either side, and impaired resonance close to the spine in the middle of the left lung. Then, apparently, that cleared up and nothing but the dulness in the upper portion of the lung remained. Now it is said that the shifting signs are one of the evidences of broncho-pneumonia. That is true; but which way do the signs shift? That is the important thing. Which way should they have shifted in this man's case?

No answer.

Doctor Sailer: They should have become more pronounced; but in this case they became less so. So it is hardly fair to assume that the broncho-pneumonia killed the patient; because the broncho-pneumonia, if there was broncho-pneumonia, and if we could suspect it on the basis of the signs, had shown improvement. Something else must have killed him. He might have been recovering from his broncho-pneumonia, but he was not. He was growing worse. What else produces shifting signs in the lung or thorax? This is the interesting point in the whole case. There is one other condition that produces shifting signs, sometimes shifting rapidly, and sometimes slowly, and this is some intrathoracic pressure. Indeed, this pressure may be even outside of the chest. I have seen marked signs in the base of the lung as the result of a large amount of ascites, which had compressed the lower lobe. It is not uncommon to find signs as the result of a large pericardial effusion compressing the lung. Even a large heart will produce the same conditions. But what about a growth producing these shifting signs some time? A large aneurism will give you occasionally, or frequently, if large enough, very bizarre and unusual signs in the chest, which do not remain very constant. Then the aneurism acts as a tumor.

Somehow or other, we rarely get tumors in Blockley, but we see them outside. These tumors replace lung tissue and produce a large number of very strange and unusual physical signs, which are not constant. So it seemed to me, on reading over these notes, that there had perhaps been a failure of interpretation. The lungs were clearing, and yet the patient was getting worse; and we must seek else-

where for an explanation. How about the bronchiectasis, which was the first diagnosis made? They thought before the autopsy that it was a bronchiectasis. What is in favor of this diagnosis?

Answer: The large amount of fluid.

Doctor Sailer: Yes; they usually expectorate a good deal of fluid from time to time. What else could produce it?

Answer: Influenza.

Doctor Sailer: Yes; he had influenza in February of this year, and died eight months later, in October. So it might have been a condition following influenza, which at first attracted little attention. What could that condition have been?

Answer: Post-influenzal inflammation or secondary fibrosis, producing dilatation.

Doctor Sailer: Yes; he had a good etiology. What are the physical signs of bronchiectasis?

Answer: Tympany on percussion.

Doctor Sailer: Yes, if the cavity is large enough. If it is not? (No reply.) If it is not large enough, then the percussion note is dull. One obtains signs that more or less resemble consolidation, on account of the large amount of connective tissue that forms around a moderately dilated bronchus. There are two types; but usually we find signs of consolidation plus a profuse expectoration, influenced considerably by the position of the patient, and often practically no signs of inflammation. But the presence of signs of inflammation in this case should not exclude bronchiectasis, because he could have had both. The small amount of sputum is the point most against it. Then there is another feature, bronchiectatic sputum is not usually almost pure pus, as this seems to have been. What does it contain?

Answer: Epithelial cells.

Doctor Sailer: Usually epithelial cells and a great deal of mucus. Still I do not know that this helps us. The sputum sometimes has a certain odor; and to one with a delicately trained nose there are probably differences between the putrid odor of gangrene and that of bronchiectasis partly due to fatty acids. I think that if any of you saw enough of these cases, you could recognize them by their odor; but seeing them only at long intervals, and not together, this is impossible, because our memory of the sense of smell becomes blunted in a short time. I am sure that I could not tell the difference by the odor, and

possibly very few people can; so the curious odor mentioned in the notes would not necessarily be against bronchiectasis; but the scanty sputum, almost pure pus, leads one to believe that we have here another kind of process. Unfortunately, the necropsy notes are attached to the clinical history. I did not read them, but I could not escape reading the pathological diagnosis, which is written in large script at the top of the first page. It was the first thing that met my eye.

Another question is, could this man have had any cardiac lesion? I wonder whether any of you suspect the right diagnosis? I have not mentioned it yet. If any one does suspect the right diagnosis, I shall consider that that particular individual deserves a "cum laude" attached to his degree. How about the cardiac condition? Is dyspnoea ever a symptom of heart disease? Is orthopnoea ever a symptom of heart disease? Was that the dominant symptom in this case? The intense fever, dyspnoea and orthopnoea might have been due to a cardiac condition. Were there any physical signs in the heart that lead to a suspicion of heart disease? He had a systolic murmur, but the heart was not particularly enlarged and, as far as I can recall, there was nothing else that would lead to such a suspicion.

Question: Where was the apex beat?

Doctor Sailer: They could not find it. I do not know whether this was because the man was fat or because his heart was displaced; but the area of cardiac dulness was not particularly displaced; it was 10½ cm. to the left and 2 cm. to the right. Suppose the man had pericarditis. You expect more dulness to the right in pericarditis than you do in the ordinary heart. Has anyone else anything to suggest? The real diagnosis has not been brought out, though I have not misled you in any way, because there is nothing in the history that would lead to the diagnosis except some remarks that I made about the physical signs in the lung.

Answer by Doctor Lucke: A student stated that the patient had complained of difficulty in swallowing.

Doctor Sailer: That is the most important point that could be added to our case. Dysphagia; he must have had it, I knew, from the diagnosis. I did not think that I was justified in going behind the returns, however, and there was no statement to indicate that he had dysphagia. What does that lead to?

Answer: Mediastinal tumor.

Doctor Sailer: It leads to a suspicion that possibly the man had a mediastinal tumor; and I spoke particularly, you remember, of the fact that in many thoracic tumors there is a curious complex of the physical signs, which are not only difficult to explain, but are apt to shift rather constantly.

I think I will turn this over to Doctor Lucke now.

Doctor Sailer: This case furnishes an opportunity perhaps for a useful but brief sermon. One of the great difficulties, I think, that we all have is to avoid being too routine in making our examinations. We get into the habit of asking a certain series of questions when we take the patient's history and when these have been answered, we move on to the next stage of the examination. Try and avoid being routine, as far as possible, and try to get to the essential part of what you are doing. No one can examine a patient thoroughly, even if he spends days doing it. You could not go over all the things to be examined, and it is not necessary. One or two points are often all that are required, if you have wit enough to discover these early. The important point in this case was the dysphagia. That should have been recorded in the notes, and should have led to further examination. When the lungs were examined by the X-ray, it was a useless procedure because it found out nothing. If a small amount of barium had been given the patient before the plate was taken, the stricture of the œsophagus would almost certainly have been discovered.

CASE II.—*Doctor Sailer:* This patient was sixty-two years old, male, white and married. He has no history. The only really important thing in this world is imagination. The only way that we progress is by someone imagining how to do a new thing or how to do an old thing in a new way; and this case will offer more scope for the imagination of the diagnosticians here than I think any other case could afford.

The patient was admitted in July, and died before a history could be obtained. He was sent in with a diagnosis of uræmia. The notes are as follows:

The patient has fairly good muscular development. He is comatose and resists efforts to move him. His breathing is typical of air hunger. This suggests decompensation or acidosis. There is a distinct odor of acetone in the breath.

Doctor Folin, of Boston, who probably knows as much about ace-

tonemia, acetonuria, and ketonuria as anyone, said that it is quite impossible to detect the odor of acetone in the breath. He said that on one occasion, when at his solicitation, one of his friends took him to see a case dying of acidosis in the course of diabetic coma, he smelt the breath, and could smell nothing but the sour odor of the gastric contents. It does seem sometimes, however, as if one could notice a distinctly acid odor resembling vinegar.

The forehead showed no skin eruptions. The cheeks were sunken and the face wrinkled, as if there had been recent loss of flesh. The eyes showed a slight puffiness of the lids, but no dark circles under the lids. Ocular tension was normal to the finger test. The pupils were equal, slightly dilated, regular in outline, and reacted to light. The eyegrounds showed nothing but sclerosis of the vessels and rather dilated veins. The nose was normal. The ears were normal. The mouth and lips were pallid and slightly cyanotic. No herpes or ulcers were present. The teeth were in poor condition in most places. There was no sponginess of the gums, no lead lines. The tongue was covered with a brown coat. The pharynx was not examined. The neck was normal excepting that the anterior and posterior cervical lymph-glands were palpable and hard. The extremities were normal. The chest was normal. The lungs were apparently normal. The percussion note was everywhere resonant. The breath sounds were vesicular throughout. A few moist râles were heard at both bases, but there were no friction rubs anywhere. The heart was apparently normal, excepting for a systolic murmur at the apex. The examination was unsatisfactory.

Abdomen: Walls tense with what appeared to be free fluid. No abnormal mass or pulsation was felt. The liver dulness was normal. The spleen could not be felt. The legs and feet were normal except for pigmentation of the skin over the legs. A purulent discharge had excoriated the skin around the scrotum. The prostate was enlarged and very hard. Otherwise it was negative. The blood-pressure was 88 and 54.

This rather rules out metastatic carcinoma of the brain which might have been suspected from the enlarged and hardened prostate.

Blood-urea nitrogen was 150 mg., about ten times the normal.

Catheterization was done and 3 cm. of urine obtained, which showed cloudiness and was full of pus cells. No casts were seen.

I have not heard the post-mortem reports. What are all the causes of coma? There are many of them.

Answer: Diabetes.

Answer: Trauma.

Doctor Sailer: Injury. Yes, that causes it—usually in what way? Usually by intracranial hemorrhage. Any other causes? This man may have been sandbagged. It is pretty hard to tell when a man has been sandbagged sometimes. What else may have caused the coma?

Answer: Uræmia.

Doctor Sailer: Unquestionably. I spoke the other day of the different types of uræmia, one of which is due to a diminution of the capacity of the kidney to excrete. In this case, the uræmia must have been, not of the type in which there is complete cessation of the kidney function, but of a type in which the power of the secretion is not lost. What else could cause this?

Answer: Thrombosis.

Doctor Sailer: Yes. Some vascular injury in the brain due to thrombosis which, of course, includes embolism, because the embolus produces thrombosis, or to hemorrhage due to effort, cough or anything that increases the intracranial tension. What else?

Answer: Meningitis.

Doctor Sailer: Yes. Various forms of inflammatory disease of the brain, including encephalitis, from generalized blood-poisoning. What else?

Answer: Certain poisons.

Doctor Sailer: Some poisons will produce it. Which, most particularly?

Answer: Carbolic acid.

Doctor Sailer: Yes. There is one which makes one stuporous.

Answer: Alcohol.

Doctor Sailer: Alcohol will slow respiration. Another that will slow respiration?

Answer: Morphine.

Doctor Sailer: Morphine is another. Coma occurs also in lead encephalopathy, as I said a minute ago. Now there is a condition in which you get a great deal of coma, and they suspect it in this case. What is that?

Answer: Lead poisoning.

Doctor Sailer: No, not that. They looked for the lead line, but did not find it. There was something in the breath that was suspicious.

Answer: Acetone.

Doctor Sailer: And what do we call that condition?

Answer: Acidosis.

Doctor Sailer: Acidosis is one of the conditions that give rise to coma. We have now inflammatory conditions, a group of chemical conditions, acidosis and uræmia, the chemical nature of which is not yet clearly known. We have a variety of poisons. We have circulatory disturbances including traumatic injury. What else?

Answer: The Stokes-Adams syndrome.

Doctor Sailer: Yes. There we have circulatory conditions which do not involve direct injury to the brain, and we must include conditions that show marked disturbances of brain substance, such as tumors. For instance, in the later stage of carcinoma of the brain, we have coma lasting for several days and very profound; or in any other brain tumor that causes disturbances of intracranial tension.

Now we can throw overboard a lot of these things in the beginning. All the intracranial conditions producing pressure may be discarded on account of the low blood-pressure. Apparently the man did not have any febrile reaction, so it is possible to throw overboard inflammatory diseases. We cannot exclude circulatory conditions, and we cannot exclude acidosis and uræmia. It is a pity that of the three cubic centimetres of urine obtained they did not apportion one for the acetone reaction. Of course, that is a small amount, and I am not surprised that they did not do it. The urine passed by catheter contained pus, so we know that he had a cystitis. He had an enlarged prostate, which must have interfered with micturation for sometime. He possibly had a secondary infection of the kidneys, going upward, which might have explained the uræmia; but, being a man of sixty-two, he might have had some diabetes producing acidosis.

TUBERCULOSIS VERRUCOSA CUTIS; LUPUS VULGARIS; LICHEN SCROFULOSORUM

FROM THE DEPARTMENTS OF DERMATOLOGY AND SYPHILOLOGY, NORTHWESTERN,
UNIVERSITY MEDICAL SCHOOL, AND COOK COUNTY HOSPITAL

By **ARTHUR WILLIAM STILLIANS, M.D.**

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THE patient is a boy of ten, small for his age and of delicate build, with a clear but somewhat pale skin. He is of Polish parentage and of a very defective family. The father has a multiple sclerosis.

The mother's mentality is rated at nine years, and she is epileptic. Two older boys are epileptic and mentally defective. One younger child is apparently in good health physically and mentally. None of the family, so far as can be determined, is syphilitic.

The mother states that the foot lesion appeared on the toes within a very short time after birth, and then gradually spread upward. Within the first two years the lesions on the instep and those on the leg had established themselves, and have since grown very slowly. No complaint of pain when he entered the hospital, but since the reaction on the leg has become established, the weeping surface is very tender, paining on motion or manipulation.

On the back of the four small toes of the left foot and extending a short distance onto the back of the foot is a warty tumor about 1.5 inches in length and breadth, and over a quarter of an inch in height. The proximal part of this mass seems to be formed by confluence of the lesions on the toes. The part belonging to the second toe is not joined to the main mass by its whole length, but ends in a projection about three-eighths of an inch in width and five-eighths inch long, pointing upward and inward, as the patient sits with this foot hanging. This whole mass is sharply defined, arising precipitately from the apparently normal skin except at the proximal border, where it slopes steeply up from the skin. The whole surface is covered by papillary projections, some soft and dark brownish red in color, but



FIG. 1.

Tuberculosis verrucosa cutis on foot and superficial lupus on leg.

FIG. 2.



Lichen scrophulosorum. Note linear grouping.

most of them covered by thick horny light brown crusts, and nowhere a sign of ulceration or moisture.

On the external anterior surface of the left instep is a roughly triangular area with a somewhat polycyclic border, the lower part occupied by a raised, warty-looking mass somewhat like that on the toes, the upper part but little elevated, covered by thin brown crusts. On removal of these a brownish red erosion is seen. This part represents fairly well the condition of the leg lesions at the time of admission to the hospital.

Just above the ankle, on the external and posterior surfaces of the leg, is a brownish red weeping erosion about 3 inches in diameter, narrowing above as if to join the narrow lower end of the lesion above, but separated from it by a bridge of fairly healthy-looking skin. Beyond the lower border of this patch are several small crusted erosions, which under the diascop are yellowish and somewhat translucent; but not enough so to give the apple-jelly appearance typical of lupus nodules. Above this is a little larger patch about 4 by $1\frac{1}{2}$ inches, of similar nature, weeping and quite tender. Upon the outer surface of the lower half of the thigh is a group of erosions from an eighth to one-fourth of an inch in diameter. These, like the patch upon the instep, are dry, covered by thin crusts.

On entering the hospital the leg lesions were dry and crusted. About two weeks ago they were, at my request, given half an erythema dose of X-rays by Doctor Mathews of the X-ray Department. About a week after the treatment they reacted, as you see, by a great increase of exudation, shedding of the crusts, and marked tenderness.

Soon after the onset of this reaction, which is a response to half the dose needed to cause the slightest reaction in normal skin, a papular eruption appeared on the chest, then on the abdomen, arms and upper thighs. These papules have now become distinctly acuminate, one-sixteenth to one-eighth inch in diameter, and many of them are capped by a tiny adherent scale. A few are round-topped and smooth. They are grouped to some extent, here and there forming lines; but even where they are thickest show no tendency to become confluent. They are dull red in color. The patient complains of considerable itching.

If we were confronted only by the warty mass upon the toes, the first thought would be of a linear verrucous nevus. The history of

onset so soon after birth, the absence of scarring, of outlying pustules, or any signs of regression during ten years, the somewhat linear configuration of the lesion, all point strongly toward this diagnosis. The lesion itself is typical of such a growth except for the slight amount of pigment, and the considerable redness of the portions from which the horny caps have been removed.

Blastomycosis is also suggested by the appearance of the toe lesion, but the sharply inclined, smooth, dark red borders, dotted with tiny abscesses, characteristic of that disease, are not to be found; there is no moisture between the warty projections, and the crusts are masses of horn, not the result of drying exudate.

Tertiary syphilis sometimes causes verrucous lesions; but these are nearly always associated with some ulceration, and cannot be conceived of lasting ten years without a greater spread and considerable scarring. The tertiary lesions do not appear so soon after birth, and are never so uniformly verrucous as this lesion.

Bromides sometimes produce large warty-looking tumors, but they are always soft and contain more or less pus. Dermatitis vegetans is a papillomatous growth upon a surface long irritated by pus. It is always moist, soft, and never horny. Tuberculosis verrucosa cutis is the form of chronic tuberculosis of the skin seen sometimes on the hands of pathologists infected from contact with tuberculous tissue at post-mortems, called therefore *verruca necrogenica*. It forms warty tumors, purulent, sometimes dry, which spread very slowly, and occur most often upon the backs of the hands or feet. That this diagnosis seems incompatible with the history I grant, but maintain that infection might occur very early in life, through the easily injured skin of infancy. Kissing the baby's foot is a common amusement for female relatives and friends, whether they are tuberculous or not. I have seen a case of *lupus vulgaris* upon the cheek of a little girl, caused by the playful rubbing of her cheek by the beard of her tuberculous father.

Taken in connection with the large erosive patches extending up the leg and thigh in the line of the lymphatics draining the dorsum of the foot, the only one of these diagnoses that could possibly fit is the last. And when on irritating the leg lesions by the action of light, an eruption of the character of that present upon the chest, abdomen and arms is the response, no doubt need remain that we are dealing with

a group of tuberculous skin lesions, tuberculosis verrucosa cutis on the foot, the superficial type of lupus vulgaris upon the leg and thigh, and lichen scrophulosorum upon the chest, abdomen and arms.

All these lesions show a more or less typical tuberculous histology. Bacilli have been demonstrated in tuberculosis verrucosa cutis and in lupus vulgaris, but never in lichen scrophulosorum. In two cases of the latter disease, inoculation of guinea-pigs with biopsy material has resulted in the development of tuberculosis in the animals, though many similar attempts have resulted negatively.

This rare tuberculide has been known to result from the inunction of tuberculin ointment, and following the injection of tuberculin in tuberculous patients. This may suggest that the eruption is a tuberculide in the strict sense of the word; that is, a result of irritation by toxins without the local presence of bacilli. The present trend of opinion is, however, toward the theory that these lesions are caused by the localization of bacilli of attenuated virulence. It seems to me reasonable that a few bacilli, even of normal virulence, might be overcome by a skin of fair resistance, and so make their discovery, even by animal inoculation, impossible.

Reactions to tuberculin have been known to release into the bloodstream swarms of bacilli, and this I believe occurred in the cases above cited. In the case before us, the slight reaction to X-rays was sufficient to produce the same result. This I have seen occur once before. A little girl on our service under X-ray treatment for tuberculosis of the bones of the foot, with sinuses and a secondary scrophuloderma, developed, soon after a treatment, lichen scrophulosorum on the sides of the chest. The papules were larger than in this case, very much less thickly sown, and faded gradually in a few months, leaving slight pigmentation.

A von Pirquet test, made a few days ago upon the left forearm between the lichen papules, was negative. This seems puzzling at first, but is easily explained by the increase of antibodies resulting from the lichen, each papule of which may be considered a centre of antibody formation. The skin has become so sensitized that the tuberculin used for the test, like the cowpox vaccine used upon an immune subject, is immediately destroyed with hardly any inflammatory reaction in the skin.

The prognosis for recovery is only fair in our case. The lichen

will probably disappear within a month or two without treatment. The other lesions will require long and careful attention to bring about recovery. X-ray will be tried again, with great caution as before. In the appearance of the lichen after X-ray treatment, we have evidence that radio-therapy, like actino-therapy, acts not only directly upon the lesion, but indirectly by creating or increasing general immunity. The treatments, then, should be just strong enough to cause a moderate reaction, one by which the patient is able to profit.

An effort will be made at the same time to obtain plenty of good food and fresh air for our young patient, that his ability to form the bodies which make for increased resistance may be enhanced. The case is remarkable, not only for the fact that three forms of tuberculosis of the skin present themselves in the same patient, but also for the absence of scarring in lesions of such long standing. No signs of chest involvement or of tuberculosis elsewhere have been found, and so far as we can learn, there is no tuberculosis in the family except this case.

A CASE OF CHRONIC NON-TUBERCULOUS PNEUMONIA

CLINIC GIVEN DECEMBER 10, 1920

By JAMES G. CARR, M.D.

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IN our teaching regarding the incidence and diagnosis of unresolved pneumonia, there has been a disposition practically to deny the existence of such a condition as a clinical entity. The easy acceptance of the diagnosis, "unresolved pneumonia" too often covered carelessness; so many of these cases proved to be empyema, tuberculosis or lung abscess, that the diagnosis of failure of resolution has been looked at askance, and the existence of such a condition regarded with skepticism. In teaching, we have felt it incumbent upon us to emphasize the dangers of such a diagnosis; the exclusion of the more common conditions has been insisted upon, sometimes to the point of denying the existence of a chronic pneumonia, independently of these conditions, or of some such specific infection as actinomycosis or syphilis. Since the pandemic of influenza with its attendant pneumonia, there has been renewed interest in chronic non-tuberculous pulmonary infections, though such conditions had been described and studied prior to that time. J. A. Miller, of New York, reviewed the literature in 1917, and reported twenty-two cases of non-tuberculous pulmonary infection. Strictly speaking, Miller's cases were not cases of "unresolved pneumonia"; a history of an ordinary pneumonia was lacking. The cases were rather of a primary subacute type, some of which showed distinct chronicity. But they did present the findings of chronic pneumonia, "with almost constant uniformity in one or both of the lower lobes," with a "lack of progression of the lesion from its original site to other parts of the lungs," and "the absence of tubercle bacilli in the sputum over long periods of time and the presence of other infectious organisms in predominating numbers." It is to the fact of this existence of chronic non-tuberculous infections that we want to direct your attention to-day; while most of the discussion will be directed to the occurrence of such infections after influenzal broncho-pneumonia, the occurrence

of such conditions independently of preceding acute pneumonia has been well established.

With the appearance of influenza in epidemic form, there was much speculation as to the effect such a respiratory infection would have on the incidence of tuberculosis. It was rather widely assumed that a disease, involving the respiratory tract to such an extent, would favor the development of tuberculosis, especially that latent foci of tuberculosis would become activated. In general, such a result has not taken place; even active cases of tuberculosis have not shown, as a rule, any tendency to aggravation of the primary disease in connection with influenza. On the other hand, it appears that chronic non-tuberculous pulmonary infections are met with greater frequency.

On the basis of the characteristic pathological changes, we might expect a greater incidence of chronic pulmonary processes after the pneumonia of influenza than occurs after the ordinary lobar pneumonia. The pneumonia superimposed on influenza is of the lobular or the interstitial broncho-pneumonic type. The extension of the infection is along the respiratory passages. Bronchitis and peribronchitis are stages in the development of the disease. The process is essentially inflammatory, with all that is thereby implied, round-celled infiltration, proliferation of fixed connective-tissue cells, vascular engorgement, etc., involving the bronchi, peribronchial tissues, and ultimately the framework of the lung. There is only a difference in the extent of the process between the intense tracheitis and bronchitis of essential influenza, and the inflammatory changes about the bronchi, and in the supporting tissue of the lung, so characteristic of influenzal broncho-pneumonia. The lobular and interstitial types may be present simultaneously; whether lobular, interstitial or mixed, the physical signs of consolidation are the result of confluence of areas of infiltration.

In the discussion of lobar pneumonia in his text-book MacCallum makes this statement: "It is to be noted that throughout this intense inflammatory affection of the lung there is very little infiltration of the lung tissue itself with the exudate. The alveolar walls and perivascular tissues remain throughout almost free from bacteria and exudate. It is rather as though the whole process were taking place upon a mucous membrane without any invasion into the depths, and it results that after the exudate is removed, there is no damage to

repair, other than the loss of the epithelial cells, which are quickly made good by those which remain, so that it would be impossible to say two weeks later that that lung had been the seat of pneumonia." The conditions in the pneumonia of influenza are different. The peribronchial thickening and the inflammatory infiltration of the interstitial tissue promise no such rapid resolution as occurs after lobar pneumonia. Slower resolution may be expected, the process may even serve to favor the persistence of foci of infection. In making routine examinations in the Base Hospital at Camp Dodge, prior to the discharge from the hospital of patients recovered from influenzal pneumonia, we found about 25 per cent. of those individuals apparently well, all of whom had had normal temperatures for at least two weeks, still had definite physical signs of pneumonic infiltration; many still had findings typical of consolidation.

Various anatomic manifestations of non-specific pulmonary infection may occur subsequent to pneumonia. It is with the chronic pneumonia type, the so-called "unresolved pneumonia," that we are now concerned. Before we present the case, which we have for consideration this morning, we want to go over the history of a patient seen last winter, and briefly discuss that case. We believe the course of this earlier case may serve to illustrate the development of the case now before us.

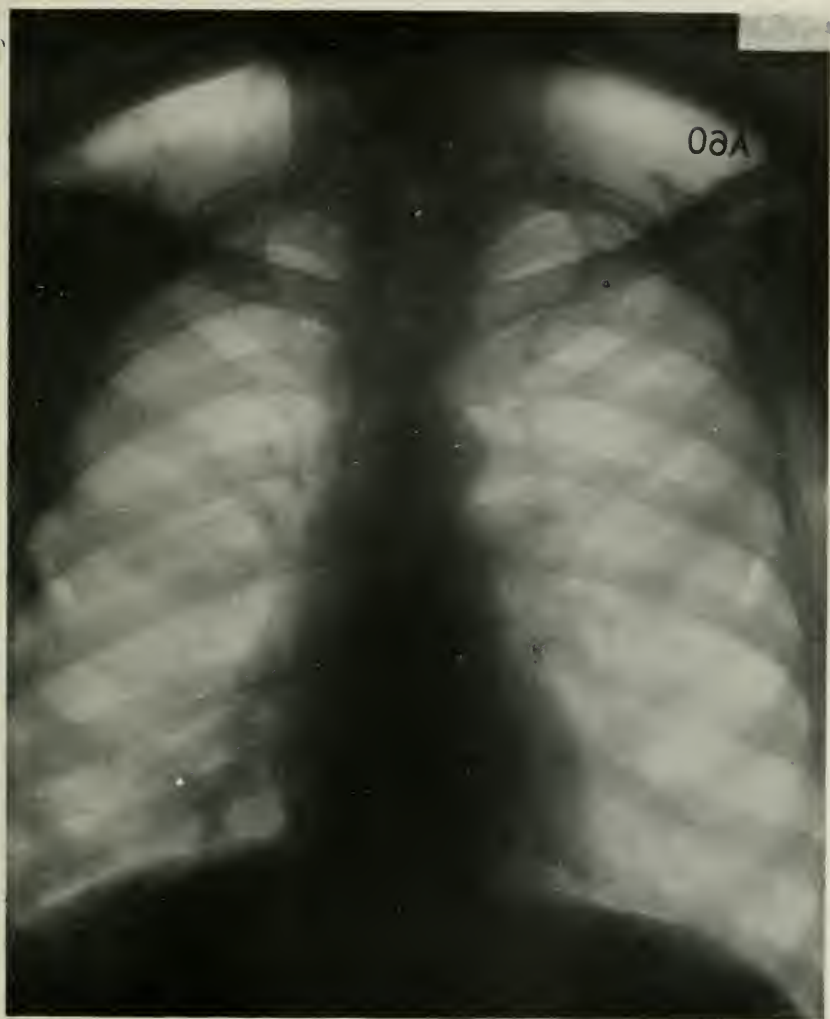
G. O., aged thirty-two, was admitted to the hospital January 30, 1920. For five days prior to his admission, he had been sick with influenza; for two days he had been expectorating a considerable quantity of blood. On the day after admission he had a profuse hæmoptysis; thereafter he shortly developed a pneumonia of the left lower lobe. On the 6th of February it was noted that dulness was present over the left lower lobe posteriorly, with a small patch of bronchial breathing, and a few crackling râles. On the 10th an X-ray report read "A shadow density in the left thorax, mostly in the lower part, which is obliterating the diaphragm. This looks like an unresolved pneumonia and pleural thickening." The leucocyte count was 14,900 on the 9th, and 16,800 on the 17th. The temperature which fell by lysis was normal after the 19th. The physical signs noted above were still present at the time of the patient's discharge on February 28th. During March the patient was seen three times; on the 23rd the dulness was still present and the voice sounds were

exaggerated over the upper part of the dull area; tactile fremitus and breath sounds were diminished. Fluid was suspected, but not confirmed by X-ray examination, which showed a shadow with the irregular outline of a broncho-pneumonia. At this time the leucocyte count was 14,800. These findings were present some eight weeks after the onset of his influenza, and thirty-three days after his temperature had returned to normal to stay. The patient felt well, was gaining strength, and was planning to return to work, which probably accounted for his failure to return for further observation. Both in the hospital and in the dispensary, where he was seen during March, his sputum was examined for tubercle bacilli. Several examinations were made, all being negative.

We recall another case seen in private practice last May. This patient, a young woman, had a history of having gone through an attack of influenza some four months before. She had not thereafter regained her strength nor her former weight. She complained also of a troublesome cough with a good bit of sputum. Over the left lower lobe posteriorly the resonance was impaired; also dulness was present in the axilla. Over these areas the voice sounds were increased and numerous moist râles were heard. There was an afternoon rise of temperature to 100° or thereabouts. The sputum was negative for tubercle bacilli. She spent the summer in the country, and apparently made a perfect recovery, as she is again studying in a local educational institution.

The patient whom we present to you this morning was admitted to the hospital September 29, 1920. He is forty-eight years of age and a laborer by occupation. He was born in Lithuania. His chief complaint was of a steady loss in weight. He has not been well since he had influenza last winter. He has a cough, which has persisted since his influenza, and is productive of a grayish sputum. He states that he has lost thirty pounds in weight in ten months. His sputum contained blood at the time of his influenza but not since. There is no family history of tuberculosis. On the first physical examination there was some roughening of the breath sounds over the right upper lobe; there was also an impairment of the resonance median to the right scapula from the middle of the scapula to the lower angle. The urine was negative. Blood-pressure was 110-70; hæmoglobin, 90 per cent.; red cells, 4,500,000; leucocytes, 7100. On October 1st a

FIG. 1.



Both lower pulmonary areas are seen to be markedly increased in density, while the upper portions are clear. (Nov. 5, 1920)

FIG. 2.



In the right lower pulmonary region there is an unusual shadow increase of irregular density . The balance of the lung areas, excepting the right apex, is relatively clear. The right apex is seen to be more or less densely infiltrated with increased tissue density. (Dec. 20, 1920)

report from the X-ray read thus: "Screen examination is negative for indications of pulmonary tuberculosis." One week later stereoscopic examination was made with the following report: "Clouding of the right apex. An area is seen in the right hilum, which has the appearance of a bronchiectatic cavity. A chronic bronchitis is suggested, but a fibroid phthisis is not ruled out." The sputum was examined for tubercle bacilli nine times; the examinations were all negative. The Wassermann reaction was negative. Three injections of tuberculin were given in doses of one-tenth, one-half and one milligram. Following the third injection there was a rise of temperature to 100° . No other evidence of reaction was noted. During his stay in the hospital the patient's temperature was normal, except on the occasion just noted, and on one other occasion, on October 9th, preceded by a chill, the temperature went to 104.6° ; within twenty-four hours it became normal. At the patient's own request, he was discharged from the hospital November 2nd.

One week later he returned to us with the statement that he had been quite sick while at home. Upon his readmission his temperature was 101.4° , pulse 120, respirations 32. On the right side the expansion was diminished. There were some loud, moist râles all over the right side, "loudest in the upper portion of the axilla. In the latter region there is increased tactile and vocal fremitus with numerous fine râles and very high-pitched, prolonged, breath sounds." Over the area median to the right scapula (the same area already described) there was still present relative dulness. Röntgenological examination now showed: "Both lower pulmonary areas are seen to be markedly increased in density, while the upper portions are very clear." The leucocytic count was 13,000.

On the 3rd of December a distinct pleural friction rub was discovered over the right base posteriorly in the axilla, and as far forward as the region of the right nipple. December 15th it was noted, "relative dulness over the entire right lower lobe; the breath sounds and fremitus are diminished over this area." At this time the right chest was aspirated and 85 c.c. of hemorrhagic fluid withdrawn. The specific gravity of this fluid was 1018. The differential cell count did not show a relative lymphocytosis. Culture of the fluid was negative. There was a leucocytosis, the count showing 14,400. Five days prior to the aspiration an X-ray examination showed: "In the right lower

pulmonary region there is an unusual shadow increase of irregular density. The balance of the lung areas, excepting the right apex, is relatively clear. The right apex is seen to be more or less densely infiltrated with increased tissue density."

During the patient's second sojourn in the hospital there have been twenty-two examinations of his sputum. No tubercle bacilli have been found. The blood Wassermann was again negative. The afebrile course of the first period in the hospital has been succeeded by an almost constant febrile course. The temperature has often gone to 101° , and most of the temperature records are above normal. The sputum has been more abundant, and of late he has had a tendency to bring up rather large amounts, an ounce or more, with a paroxysm of coughing. The typical qualities, generally attributed to the sputum in lung abscess, have not been present. The patient's general condition is distinctly worse than it was two months ago. On the whole, he has failed steadily, and this has been more marked since his attack of pleurisy. There is now relative dullness over the lower half of the right lung posteriorly. Over the left base behind the resonance is diminished. Scattered dry râles are heard over the entire right side. Some fine moist râles are heard over the right base. A friction rub is very plain over the entire right base; it is most distinct in the axilla and anteriorly as far as the nipple. Over the area of dullness mentioned, tactile and vocal fremitus are diminished, the voice and breath sounds being distant. We now accept an anatomical diagnosis of chronic pneumonia of the right lower lobe, with chronic adhesive pleuritis. There is some infiltration of the left lower lobe, and a diffuse bronchitis, chronic in type, moderate in degree.

The question of diagnosis, however, is more interesting from the standpoint of etiology than of pathology. Is the process tuberculous or not? With a chronic pulmonary disease, especially when associated with even minor apical involvement, our first problem is to prove or disprove tuberculosis. The constitutional symptoms here presented might be present with any chronic pulmonary infection. The long afebrile period, definitely proven by weeks of observation during his first stay in the hospital, and thus proven, after his symptoms had existed for months, and in the presence of fairly well defined physical signs, may be accepted as probable evidence against tuberculosis. Active tuberculosis is, at least, likely to be associated with some rise

of temperature daily, particularly if a patient is up and about, as this man was, most of the time in October. The evidence derived from the location of the most obvious pathology in the lower lobe may be regarded as questionable. It is quite widely assumed that primary lower lobe involvement excludes tuberculosis. We are not sure that this idea is a proven fact, which may be dogmatically taught. Even though such were granted, the slight evidence of right apical involvement might point to that location as the seat of the primary disease, with extension to the lower portion of the lung. The outstanding fact is the continual failure to demonstrate tubercle bacilli in the sputum. Thirty-one negative examinations certainly give us no warrant to diagnose tuberculosis. As a general rule, we believe that, in the presence of well-defined pulmonary disease, the continual absence of tubercle bacilli from the sputum may be accepted as very strong evidence against the presence of tuberculosis. Certainly, under such circumstances, it is necessary to exclude all possible causes of chronic pulmonary disease, simulating tuberculosis, before even a tentative diagnosis of tuberculosis is accepted. In view of the long time during which this patient has been under observation, with steady progress of the disease during that time, with the aggravation of the constitutional symptoms and the extension of the process as revealed on physical examination, and with the absence of tubercle bacilli from the sputum, we believe this to be a case of non-tuberculous infection, a chronic pneumonia of non-specific origin. The restriction of the progressive process to the lower lobe, while the uncertain findings in the apex have remained unchanged, may be accepted as subordinate evidence tending to confirm the non-tuberculous character of the infection.

Except bronchiectasis, none of the various types of non-specific pulmonary infection require differentiation. The possibility of bronchiectasis was suggested in an early X-ray report, noting a possible bronchiectatic cavity. The question was raised again by the paroxysmal expectoration of sputum which has occurred recently. The suggestion coming from the X-ray department was of unusual interest to us, as we were reminded of a case which we saw in the summer of 1919. This patient was admitted to the hospital with an acute pleurisy. In September, 1918, he had gone through an attack of influenza from which he had never fully recovered, though he had returned to work for several months. Examination in the hospital

resulted in a diagnosis of abscess of the left lower lobe. Some six weeks later, after three severe pulmonary hemorrhages, the patient expired. Autopsy disclosed an old bronchiectasis, with a surrounding broncho-pneumonia of some standing, merging into a fresh pneumonia, and associated with a fibrinous pleurisy. In the case present here we have a similar sequence, a history of influenza, followed not by recovery, but by the persistence of symptoms regarded as insignificant. On admission to the hospital we find chronic bronchitis with probable broncho-pneumonia. The pneumonic findings became more distinct, the constitutional symptoms increased in severity. Later the signs of pleurisy are unequivocal and fluid is demonstrated. One is tempted, on the basis of the earlier case, to elaborate a diagnosis in the case here presented.

From the physical examination it seems clear that we are dealing with a chronic non-tuberculous broncho-pneumonia. The history sustains us in the opinion that this condition has developed as a result of an influenzal pneumonia. The case is not interesting because it is unique, rather does it claim our attention and interest because similar conditions have been observed, more or less frequently, since the prevalence of influenza. Obviously, our former disposition to throw out of court all diagnoses of "unresolved pneumonia" must be restrained. Here, as always, diagnosis must be based on evidence, and the mere continuance of symptoms subsequent to acute pulmonary disease does not justify the diagnosis of "unresolved pneumonia." Yet it is true that chronic inflammatory processes of the lung do occur, independently of tuberculosis, actinomycosis or syphilis, and that such may be present after pneumonia without empyema or abscess. This non-specific type of inflammation has been more common subsequent to influenzal broncho-pneumonia, though it may follow other conditions, or even come on insidiously and occur without history of previous disease. Until the lobar type of pneumonia once more predominates, it seems likely that "unresolved pneumonia" will be fairly common. Recently more of our pneumonia cases have been of the old type, but throughout the summer and fall, atypical cases simulating influenzal broncho-pneumonia, but with an immediate onset, were often seen.

Chronic non-tuberculous pneumonia does occur. The prognosis in an early case is good. Most of the cases go on to recovery, though

that is gradual. With duration of the disease the likelihood of eventual recovery diminishes. Physical findings without constitutional symptoms are insignificant. With such symptoms, however, there must be present an active infective process. The therapeutic indication is clear. Persistence of symptoms and physical signs after pneumonia means treatment along the lines followed in tuberculosis, until symptoms have disappeared, and the signs are likewise gone, or those which point to healed disease are found. Rest, fresh air, food, these are the essentials of treatment. Often some sedative is necessary for the cough. Neither creosote nor potassium iodide have convinced us of their value, though both have been tried. Similar as this line of treatment is to that of pulmonary tuberculosis, the diagnosis between the two conditions is important, not alone to avoid the loss of morale, which comes to many patients with the word "tuberculosis," but principally that patients, already weakened by chronic disease, should not be exposed to further infection from association with tuberculous patients. The non-tuberculous case should be kept out of any such institution, unless provision for individual isolation is adequate.

RADICAL SURGERY AS AN AID TO EFFICIENT RADIO-THERAPY IN THE APPARENTLY HOPELESS CASES OF CARCINOMA *

By DR. EMIL G. BECK, F.A.C.S.

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AFTER years of ceaseless search for a specific remedy, surgery still holds first place in the treatment of cancer and will probably retain that place until its cause has been discovered. Radium and other radioactive substances and the X-rays stand next in efficacy to-day. All other methods with but few exceptions have fallen into obscurity after they have lived the short life which the enthusiastic author in such case has been able to create for them. I can mention only a few of these, such as bacterial products, serums, arsenical preparations, atoxyl, salvarsan, kankroin, anti-tuman, quinine, resorcin, kollargel, eosin, selenosin, cholin, etc.

This does not mean that we shall cease in our efforts to find a specific. We may some day, when we have learned more of the etiology of cancer, be able to produce sera or chemical substances which will make the growth of cancer in the human body impossible. For the present, we shall take advantage in the fullest measure of the means we know to be efficacious, namely, *Surgery* and *Radiotherapy*, or the combination of both.

In this discourse I shall confine myself to the discussion of advanced cases in which surgical operation seemed inadvisable, or in which one or more surgical operations had already been performed and recurrence had taken place. In choosing such material for our work, we must not get discouraged. We cannot expect the impossible. Neither must we enter upon this work in a half-hearted way. If we do we are apt to fail in doing our best. We enjoy other advantages in choosing this class of cases. We obtain greater coöperation with our patients. When we have failed we are not likely to be reproached and if we succeed in only a few we shall have accomplished something.

* Read before the Chicago Surgical Society, October, 1920. Read before the Southern Minnesota Medical Association, November, 1920.

It is regrettable that such deplorable cases should exist at all. With all of our efforts to educate the public and our attempts to drive out the quacks for robbing a credulous unfortunate individual of the one chance for his life; with all of our teachings and preaching to surgeons to operate carcinoma early and radically; with all of these efforts, we still meet with so many hopeless cases. Is it not discouraging?

When confronted with a recurrent carcinoma of the breast or neck, for instance, the surgeon is apt to be too pessimistic. Usually the patient is referred to a röntgenologist for radium or X-ray treatment, partly to satisfy the hopes of the patient who in his despair is happy to believe that something more can be done for him, and partly because the surgeon does not yet know definitely the possibilities of radium and X-ray therapy. He hesitates to do anything more surgically because he feels that if he was not able to eradicate all of the cancerous growth at the first operation, a second operation is liable to be much more difficult, and not likely to be as radical as the first one. While recurrent cancer is not a promising field for the surgeon, still it seems to me that we have not yet exhausted all of our efforts in combatting this dreadful disease. I have come to the conclusion that even in apparently hopeless cases something can be done, and I desire here to present a few suggestions:

Before recommending radium or X-ray, let us first investigate impartially their status in cancer therapy. What methods of investigation are available to arrive at the facts? Let us look up the credentials of those who advocate radium. The literature should be our main guide. The reports from clinics and individual observers of carefully recorded cases and our own experiences shall be our main witnesses. One who has followed the literature pertaining to this subject since 1910 cannot fail to be convinced that radium and X-ray when applied scientifically can produce beneficial results. The sceptic will ask, "If radium cures cancer, why do so many people die of cancer? If it can cure one case, why not all?" Our answer would be, "Why cannot all target shooters hit the mark every time?"

Many cases of cancer are treated with radium and X-ray by the most incompetent. Radium therapy is still in its experimental stage. The mortality from resections of cancer of the stomach was at one time 100 per cent. See what it is to-day. It took time to develop

and perfect the technic. The use of radium, like all other methods, should be employed by the competent. It is not sufficient, however, to leave the entire treatment to an expert physicist who knows all about the properties of radioactive substances, and very little about pathology. It would be analogous to the idea of employing a chemist to treat heart diseases, because he had a knowledge of drugs. It requires an evenly balanced knowledge of pathology, surgery and physics, in order to achieve the desired results.

We have all noted the beneficial effect of radium on superficial growths such as epithelioma, which is essentially a malignant growth. The question naturally arises: If radium can destroy a superficial growth, why cannot it also destroy deep-seated carcinoma? Answer: Either the deep-seated carcinoma is made up of more resistant cellular life, or the rays are not able to reach the tumor on account of the overlying structures. I am led to the conclusion that the latter is the factor, namely, that the deep-seated carcinoma when covered with skin, fat and muscle cannot be treated quite as efficiently by radium, because these overlying tissues are barriers to the softer rays or the beta, and some of the gamma rays of radium.

With the coöperation of Mr. W. G. Warner, the physicist of the Ryerson Laboratories, I published in *Surgery, Gynecology and Obstetrics* (October, 1919) some experimental work which proved that human skin, fat and muscles absorb large quantities of X-rays. The accompanying Fig. 1 illustrates graphically the absorption of X-ray by the skin, fat and muscles compared with the absorption by different thicknesses of aluminum.

The skin, fat and muscles which cover a deep-seated growth may be regarded as barriers to the penetration of the rays. They act as additional filters to the artificial filters of lead and aluminum which the operator usually employs to prevent burns of the skin. This is only one factor which diminishes the action of the radium. Another factor is this:

In order to prevent burns the radiologist interposes wooden blocks or similar substances to keep the radium a certain distance from the skin. In doing this he again minimizes the action of radium. By placing, for instance, 50 mgr. of radium upon a wooden block one inch square, we obtain only the rays which penetrate downward toward the block and lose all the rays which emanate upward and sideways.

If the same capsule of 50 mgr. of radium were inserted into the tumor itself, the radium rays would penetrate from all surfaces of the capsule and affect the growth in all directions (see Fig. 2).

FIG. 1

*Absorption of X Rays by
Skin, Fat, Muscle, compared with $\frac{1}{5}$ $\frac{2}{5}$ $\frac{3}{5}$ in. Alumin*

X Ray Absorber	Aluminium			Human Skin	Fat 15 mm.	Muscle 20 mm.
	$\frac{1}{5}$ in.	$\frac{2}{5}$ in.	$\frac{3}{5}$ in.			
10%						
20%						
30%	26.18					
40%						
50%		39.62				
60%			48.88	49.52		
70%					60.99	
80%						75.28
90%						
100%						

Relative absorption of X-rays by skin, fat and muscles compared with various thicknesses of aluminium.

The present methods of application of radium have, therefore, three shortcomings:

1. By placing the radium at a distance from the growth we diminish the activity.
2. By placing artificial screening of lead or leather over the skin, we filter out the most effective rays.
3. A further reduction of activity of the rays is obtained by an additional absorption of rays by the skin and underlying tissues.

Thus we deliver into the tumor only a fraction of what might have been accomplished if the radium was placed within the growth itself.

I have come thus to the conviction that deep-seated cancer does not yield readily to the treatment with the radium because the skin, fat and muscles are distinct barriers to the action of the most effective radium rays—namely, some of the beta and a large portion of the gamma rays.

This fact suggested the idea that, *If the Skin, Muscle and Fat and as Much Cancer Tissue as Possible Could Be Removed, so as to*

FIG. 2.

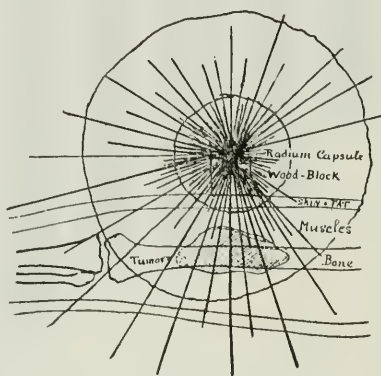


Fig II. Action of Radium
diminishing with Distance and Filter.

Action of radium diminishing with distance and filter.

Leave Only Remnants of the Growth, the Radium or X-ray Could Be Applied Directly into the Cancer Bed with no Obstruction to the Activity of the Rays. In other words, we could transform the deep-seated growth into a superficial one. To illustrate this principle, we shall make a schematic drawing which represents a cross section of the body, in the centre of which is located a malignant tumor.

Let us suppose that the tumor in this case is about four inches from the surface of the skin. In order that the rays may reach the tumor, they must penetrate and pass throughout overlying tissues. These tissues will absorb all the beta and a portion of the gamma rays. The gamma rays being very penetrating will reach the tumor; but that does not mean that all of them will be arrested in the tumor mass. A certain quantity will be arrested in the growth itself and the

balance will pass through the tissues beyond the tumor. When a ray is arrested in the cell, it will probably have a more deleterious effect upon the life of the cell. If it passes through the cell, it will no doubt injure it also; but not in the same degree as it would if it were actually arrested in it. We cannot ignore, therefore, the fact that the tissues above and beyond the tumor must suffer also. The burn of the skin proves this assertion.

When treating deep-seated carcinoma—having overlying tissues—we are obliged to use larger doses and more penetrating rays in order to deliver into the tumor the required dosage of rays for its destruction. If, for instance, three inches of fat and muscle intervene between the skin and the tumor, it will require much larger quantities of radium properly screened to obtain the required dosage than it would if the tumor were on the surface. By placing the radium directly into the cancer bed, smaller doses are sufficient. By reducing the dosage, the action of the penetrating rays upon the structures beyond the tumor will be cut at least 50 per cent., thus sparing the normal tissues above and below the growth with consequent reduction of chances of producing a toxæmia.

ACTION OF RADIUM ON CANCER CELLS AS COMPARED WITH NORMAL CELLS

Competent observers have stated that radium rays have a selective action on embryonic cells, and that it would require approximately five times the dosage of rays to destroy a normal tissue cell that it would require to destroy a cancer cell. This phenomenon requires an explanation. What physical law indicates that a ray will select one type of cell in preference to another?

Would it not be more plausible to assume that the cancer cell has less resisting power against the injury of the ray than the normal cell? This assumption is further strengthened by the fact that the cancer cell is more easily injured by heat. Doctor Percy, of Galesburg, has demonstrated that heat will coagulate cancer cells at a temperature from 15 to 30 degrees lower than that required for the destruction of the normal tissues; thus in applying graduated heat in carcinomatous regions the cancer cells will perish while the normal cells will be spared within certain limitations of heat and distance.

To account for this lack of resistance in the cancer cell, or rather

for the defence which a normal cell possesses, nothing definite is known. Many theories have been advanced, some of which seem reasonable, others less so. One of the most favorite theories is the *embryonal*. It has been stated that the cancer cell is an embryonic cell and that all embryonic cells are less resistant, therefore liable to be destroyed by X-rays. This assertion brings up another question. How long does an embryonic cancer cell remain embryonic? Does it ever become mature? All cellular structures before they become mature must pass through the embryonal stage just as human beings do. Whether the same law holds good in the case of cancer I do not know. Is it possible that the cancer keeps on increasing in size and still the cells remain embryonic?

Normal cells belonging to the body organization pass through the embryonal stage—become mature, fulfil their function and when they are old, they are broken down, eliminated, and replaced by new cells (metabolism). Does this also take place in the case of cancer, or does the cancer cell reproduction go on indefinitely without being broken down until exposed to external injuries, such as X-ray, heat, surgery or accidents? If the rays are really more injurious to all embryonal cells, whether they be the embryonal of the normal tissues or the cancer cell, it would be a most dangerous procedure to expose the body to the ray because it would destroy the normal embryonal cell, which would mean practically gradual cell extinction. There must be some other factors in operation which give the normal cell protection against external injuries.

May I be pardoned in advancing another theory? This theory may serve by analogical reasoning, to approach the truth of the matter. It is as follows:

A mass of cancer cells may be likened to an alienated detached and lawless community the members of which have no other function than reproduction and self-nutriments. They know how to appropriate for themselves plenty of nourishment at the expense of the whole body. These cells grow without any definite arrangement of structure or function, in a lawless manner, and *do not give any counter-service to the organism in return for the nutriment they receive.*

The growth is not under the control of the central nervous system. This community of cancer cells may be justly likened to some insurgent state or some groups of revolting men we often find in peaceful

communities, who do not wish to perform any labor and ask for everything that labor produces. They, too, appropriate plenty of nutriment for themselves in a lawless manner, a sort of anarchistic community.

Is it not likely that these recalcitrant cells (cancer cells), which render no service to the whole, are denied the same protection against all sorts of injuries which the normal working cell of the body receives? The normal cell belongs to the organism and is under the control and protection of the cell community. It may be that some enzyme or lack of some substance of the normal cell or some faulty arrangement of the chromozome weakens the resistance of the cancer cell.

Parallels have been drawn between the organization of human beings and cells to illustrate that our body is merely a composite of many individual little beings each contributing to the welfare of the whole, just as each citizen contributes to the welfare of the human race. How far this coöperation in cell life carries its function and habits we do not know. Cells may be even better organized than the human family.

The present state of affairs among nations does not indicate a superiority of human organization over cell organization. There may be in the cell organization laws governing the nutrition and protection of the segregated clusters of recalcitrant cells. If there are cell workers, cell soldiers, cell judges, then why not cell thieves and cell prisoners? And so by analogy we may consistently reason that cancer cells do not share the same privileges that the normal working cells enjoy.

The central nervous system which is the most important factor in the protection to cell life is absent in the carcinoma growth. Pain which is associated with carcinoma is felt in the surrounding structures upon which the tumor impinges. This pain is a sign for help when the growth is trying to invade farther into the normal structures. The cancer itself has no sensitive nerve fibres and may be cauterized or cut into without the patient's discomfort, providing the surrounding structures are not touched.

This theory does not conflict in any way with the theory of irritation of epithelial surfaces. In fact, it would corroborate it. It may be easily explained that by some undue irritation the resting

cells are called prematurely into activity, a process which may lead to lawless reproduction by their detachment from the central nervous system.

Having now outlined a mode of procedure by which we would obtain the maximum benefit from the combination of surgery and radiography and having advanced a theory by which I attempt to explain why a cancer cell succumbs more quickly to radium than the normal cell, I will cite a few from a series of fifty cases to illustrate what may be gained by following my suggestion.

SARCOMA OF THE RIGHT LUNG—REMOVAL OF INTERIOR OF TUMOR SUBSEQUENT RADIUM THERAPY WITHIN THE CAVITY

Patient was referred to me on September 28, 1920, with the following history:

She was then twenty-three years of age, unmarried, and her best weight was 126; present weight, 124. Three examinations of sputum revealed no tubercle bacilli. Wassermann negative; complement fixation for tuberculosis negative. Afternoon temperature 99.1. Physical examination showed a few moist râles over the right hilus in front and back with no change in the percussion note. There was some slight enlargement of the thyroid. The X-ray stereos showed a well-defined, clean-cut hilus shadow in the centre of which was another round-shaped shadow about the size of a twenty-five-cent piece. It was so round in shape and abrupt in its outer margin as to attract attention. It was not typical of tuberculosis or of anything which involved the lung tissue proper. In three weeks the fever and sputum had disappeared, and the patient resumed her work as a nurse.

On April 7, 1920, the patient returned on account of the same symptoms of blood spitting followed by some clots, cough and sputum. The cough had persisted for about three months prior to this, but the weight remained the same. Physical examination showed more decided dulness over the right hilus in the back. The X-ray showed that this original shadow was about three times as large. It was round and suggested the text-book description of a hydatid cyst. Thinking that it might be a hydatid cyst, we made careful blood examination. No eosinophilia was ever found. Weinberg's antigen and a complement fixation with this antigen *was negative*. Wassermann and complement fixation for tuberculosis were negative.

FIG. 3.

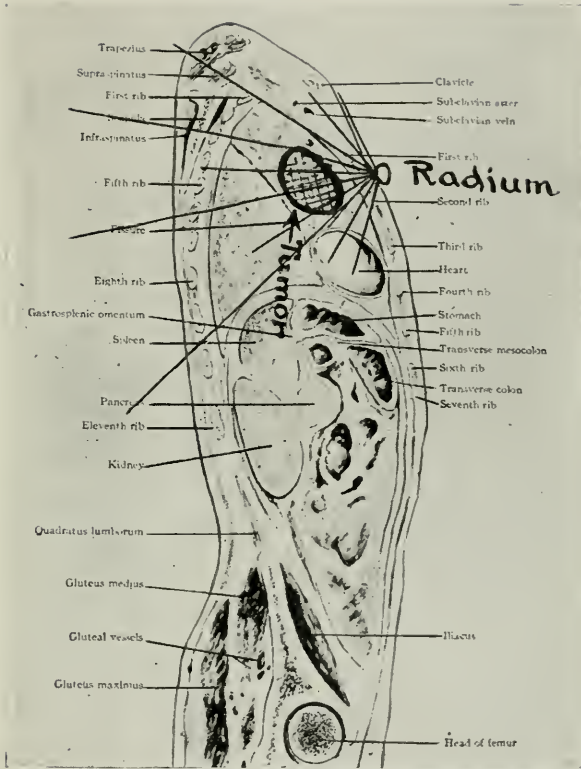
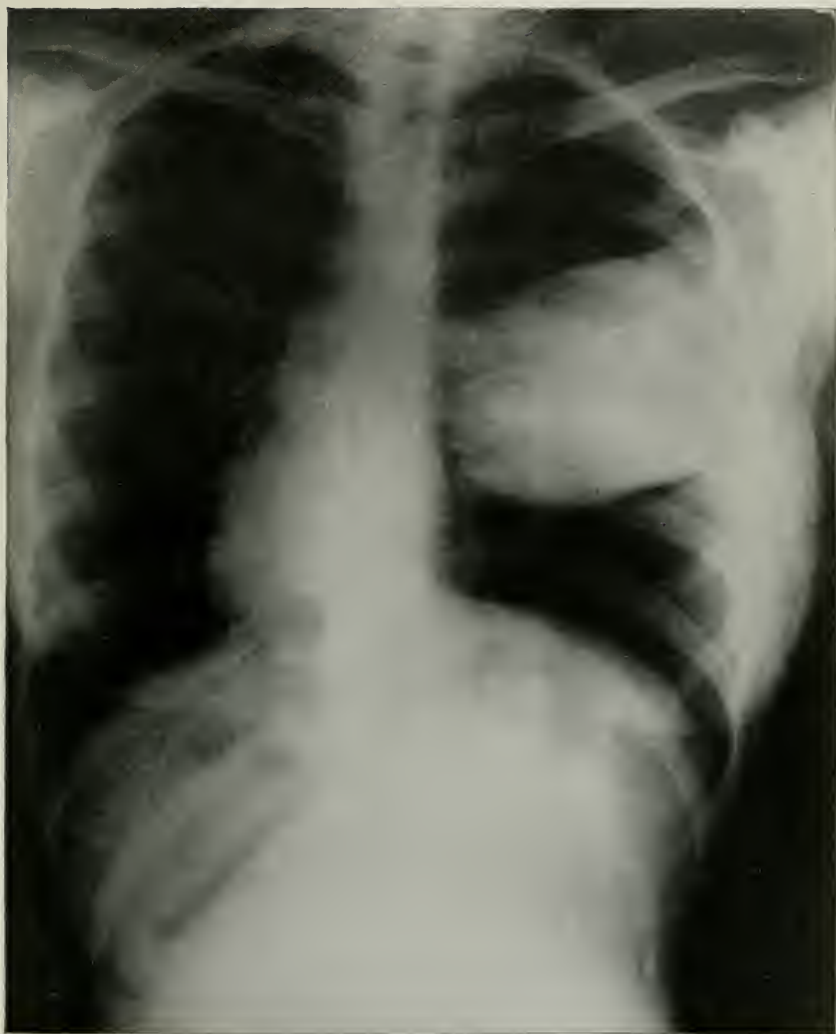


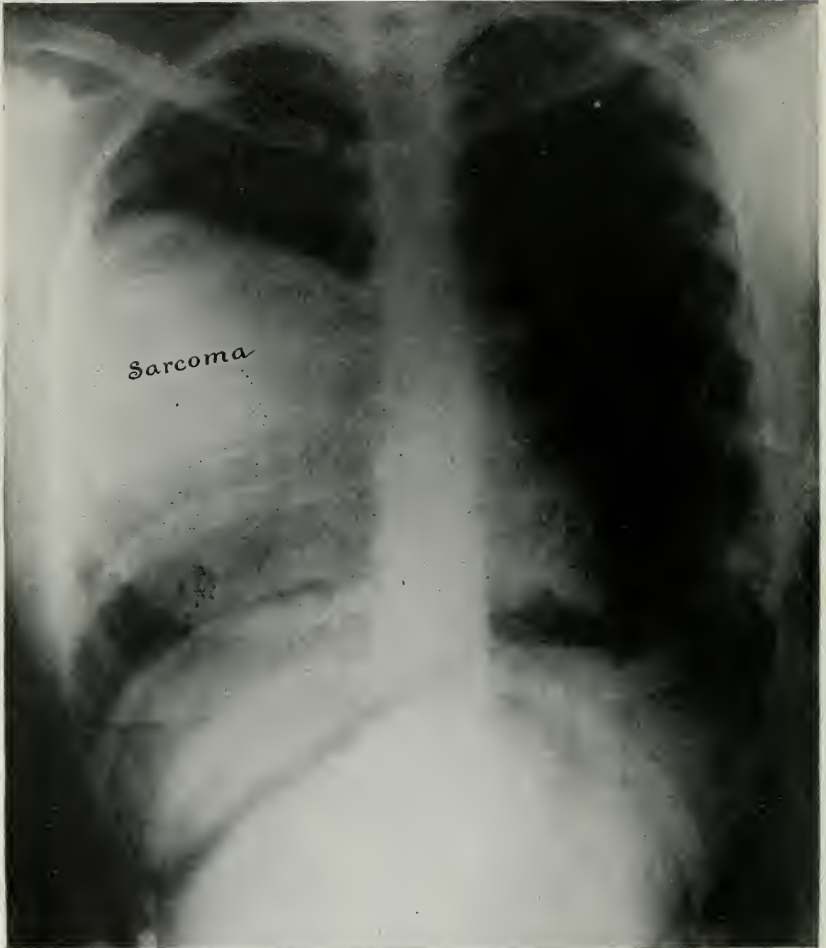
Illustration of absorption of rays by tissue above and below the tumor when deep seated.

FIG. 4.



Radiogram of sarcoma of the lung, illustrating size, July, 1920.

FIG. 5.



Radiogram illustrating size of the same tumor, Sept. 28, 1920.

In July, 1920, physical examination showed feeble breath sounds between the second and fifth ribs with a few crepitations. The tumescence in the lung was about the size of a navel orange (Fig. 4). The sputum was negative for tubercle bacilli and for echinococcus hooklets. Neither could pus cells or elastic tissue be demonstrated.

On September 10, 1920, the patient had another attack, cough and some hæmoptysis followed by bloody sputum for several days and an elevation in temperature. During this time the pupils were dilated. The physical signs were more definite over the right lung, and the X-ray showed that the tumescence had increased and was as big as a grapefruit. Present weight, 116.

September 21, 1920: Examination of the chest. *Right lung:* Dulness as low as the sixth rib. Fine râles in the first and second interspaces. The breath sounds, however, are not decidedly interfered with.

Left lung: Normal.

When I saw her September 28, 1920, her condition was as follows:

She complains of shortness of breath; coughing mornings; expectorating small quantities of rusty sputum; losing slightly in weight; otherwise she was apparently normal.

Stereoröntgenograms revealed a tumor which occupied two-thirds of the right chest cavity; oval in shape and lying transversely within the diameter, reaching from the heart to the ribs (see Fig. 5).

A puncture was made with a long trocart and about 10 c.c. of a fluid (almost normal blood) was withdrawn. This did not ascertain the diagnosis and operation was decided upon and carried out in two stages, as follows:

October 15, 1920. *Primary operation* (under general anæsthesia). A skinflap including muscles and fat seven inches in diameter was raised (see Fig. 6). Six inches of each of the fifth, sixth and seventh ribs were resected, exposing the pleura over the tumor mass. The skinflap was rolled up and fastened with sutures, thus leaving the entire square about seven inches in diameter) exposed. The exposed pleura was then cauterized with silver nitrate stick in order to produce adhesions between the tumor and the pleura. The open wound was dressed with vaseline gauze.

October 18, 1920. *Second operation*—three days later—under

general anæsthesia (gas and ether). The wound was exposed and a purse-string suture placed in the centre of it to insure quick closure in case there should be uncontrollable hemorrhage. The tumor wall was then incised; the capsule was rather firm but the interior of the tumor was composed of a semi-solid brain-like tissue; somewhat more solid, but not homogeneous. More solid portions than softer portions. It was possible to evacuate the contents in similar manner of delivering an adherent placenta. The mass was not entirely removed, although it would have been possible at the risk of more severe hemorrhage as we could introduce the entire hand and wrist into the cavity and reach all portions, but we were satisfied to have opened the cavity and eliminated the greater part of the mass without breaking the capsule. The cavity was quickly packed with twelve face gauze sponges (Fig. 7). Patient left the operating room in good condition.

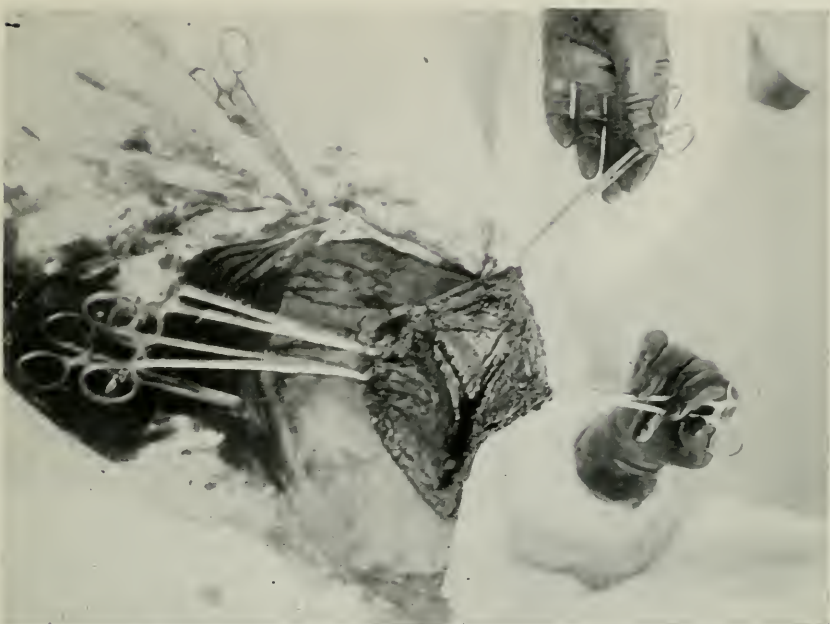
After-treatment.—Forty-eight hours after, the twelve soft gauze sponges were removed under anæsthesia. There was no hemorrhage. We removed another four or five ounces of the tumor mass from certain recesses of the enveloping capsule. The cavity was repacked. One week after the operation 50 millimetres of radium were introduced into the cavity in the centre of a rubber ball, giving 600 mgr. hours (Fig. 8). The wound was dressed daily and the following dosage of radium was introduced on the following dates:

October 28, 1920	600 Mgr. hours
November 8, 1920	425 Mgr. hours
November 18, 1920	450 Mgr. hours
December 13, 1920	400 Mgr. hours
December 22, 1920	300 Mgr. hours
January 14, 1920	450 Mgr. hours

The patient continues to improve and is gaining in weight on the average of two pounds weekly. The cavity has shrunk to one-twentieth its previous size. There are some small necrotic masses resembling degenerated sarcoma structure. The bronchial opening is still present, and when the patient is about to inhale or exhale there is a discharge of a serous mucoid substance (Fig. 9).

Stereoröntgenograms taken (Fig. 10) four weeks after the operation show only a small remnant of the tumor mass, and the tumor wall very thin.

FIG. 6.



First step in operation exposing pleura overlying the tumor.

FIG. 7.



Removal of contents of tumor. (Note the cavity is packed with gauze.)

FIG. 8.



Size of cavity two weeks after operation—ready for radium insertion.

FIG. 9.



Size of wound reduction four weeks subsequent to operation.

Pathological Report.—The microscopic section of the tumor showed a spindle-cell sarcoma (see Fig. 11).

The final report is reserved and will be made in about one year.

MALIGNANT OVARIAN CYST (CYST-ADENOMA) TREATED BY
OPEN METHOD

Mrs. E. S., sixty-six years old, entered the hospital March 10, 1919. Since December, 1918, she noticed that her abdomen had grown to a very large size. She lost control of her bladder and lost considerably in weight. Her legs were swollen up to her knees. The diagnosis had already been made by her physician as a malignant ovarian cyst.

An exploration was made, the diagnosis was confirmed and the case was considered inoperable. There was some fluid in the abdomen and intestines, and the enormous tumor was matted with intestines and studded with small growths resembling papillomata.

The abdomen was closed. She received X-ray treatment for six months, which did not benefit her, for no effect was produced. The abdomen grew larger and larger until she could hardly breathe (Fig. 12).

In her desperation she insisted upon an operation, and the same was performed November 15, 1919, as follows:

Median incision from the ensiform cartilage to the pubes to deliver the tumor out of the abdomen. The loops of the intestines were firmly adherent to the base of the tumor. The tumor itself was firmly attached in the entire pelvis and thus was not removable in its entirety. The cyst was, therefore, opened and its contents, a gelatinous mass, removed (about five quarts in quantity).

The upper two-thirds of the tumor was then amputated. The wall of the tumor being two to three inches thick in certain portions and again thinner in other parts. The edges of the skin were then sutured to the rim of the amputated cysts and the cavity packed with gauze so that there was a funnel-shaped cavity reaching the lowest part of the pelvis.

The interior of the cyst was then treated by direct application of radium at intervals of three weeks—700 to 1000 mgr. hours being given each time. The radium treatments were supplemented with deep therapy, one erythem dose given every second day.

The cavity gradually diminished in size by contraction of its walls and absorption of the tumor, and the patient gained in general health and strength.

The abdominal opening into the cyst remained open for sixteen weeks in a suppurating condition, but finally closed, remaining so up to date—nearly a year and a half after operation. The patient is now attending to her daily housework, and has been able to take care of a very sick husband for nearly four months.

Fig. 13 shows introduction of radium into the cavity by curved applicator.

Comments.—(A) By eversion of the interior of a malignant cyst, we transformed an intra-abdominal into an external-abdominal tumor, and thus are able to apply X-ray and radium directly into the seat of malignancy. (B) It is safer to treat the tumor in this manner compared to the attempt of complete enucleation. (C) It is preferable to treat with radium combined with X-ray than either alone.

PRIMARY SARCOMA OF THE LUNG AND SHOULDER

For illustration of the attempt to treat sarcoma of the lung which involved also the neck and shoulder, I present the following:

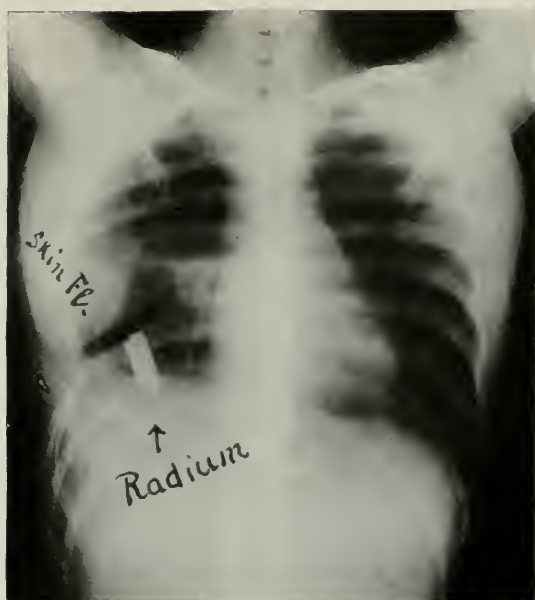
A. H., a boy fifteen years of age, was operated on April 28, 1920, for lympho-sarcoma of the shoulder. Two months later a rapid recurrence was noted. The patient began to lose in weight and the entire left side of the chest began to enlarge.

The patient presented himself December 3, 1920. He was anæmic. He had a swelling on the left shoulder extending from the middle line of the chest toward the shoulder, so that at present the anterior posterior diameter was several inches larger on the left than on the right (see Fig. 14). There is a hard mass involving the axilla, neck, and chest; the left pupil is smaller than the right. The pulse in the left wrist is hardly palpable, and his blood-pressure does not register at all, while on the right side it is 130 over 90.

The röntgenograms of the chest disclose a large tumor involving the upper part of the chest cavity and the region of the neck, shown in Fig. 15.

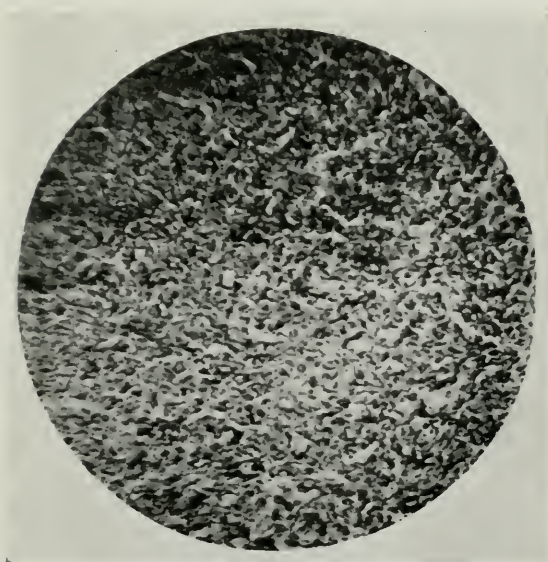
Amputation of the shoulder was refused by the patient and the open method exposing the tumor for the purpose of radium and X-ray was decided upon.

FIG. 10.



Radiogram of chest taken four weeks after operation. Radium within the cavity.

FIG. 11.



Microscopic section of tumor showing spindle cell sarcoma.

FIG. 12.



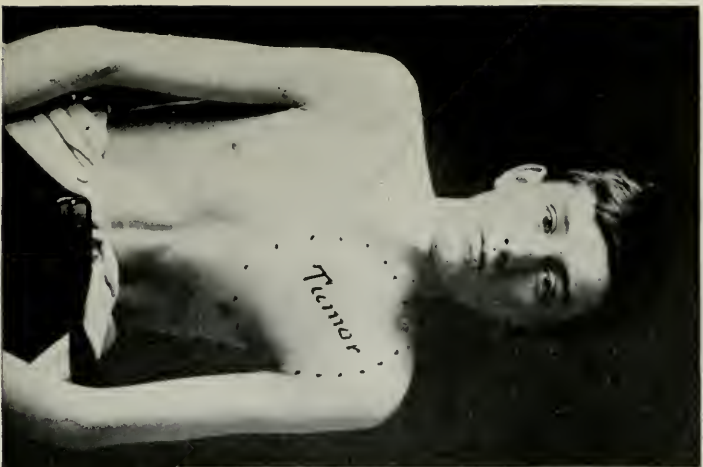
Malignant ovarian cyst. Size of the abdomen before operation.

FIG. 13.



Application of radium through funnel shaped crater into the interior of the cyst cavity.

FIG. 14.



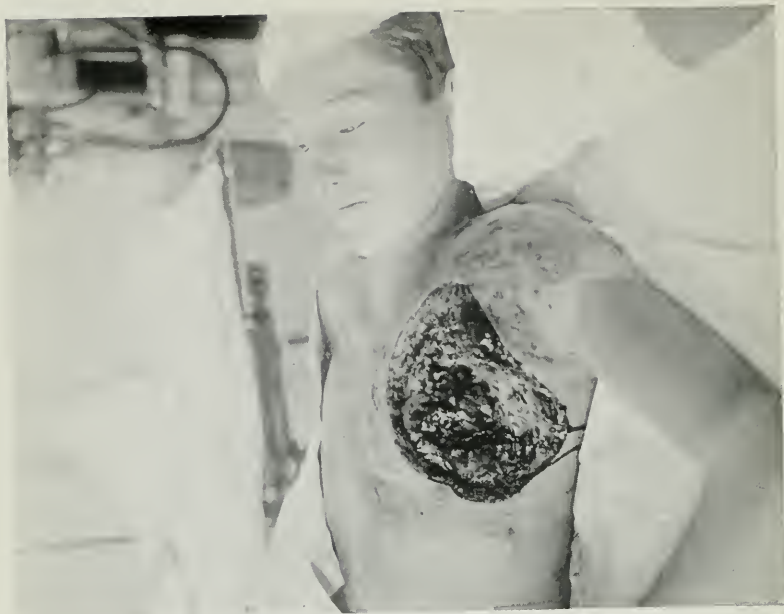
Sarcoma of left lung and shoulder, with enlargement of the chest.

FIG. 15.



Radiogram showing size of sarcoma within chest and shoulder.

FIG. 17.



Sloughing of tumor after first radium treatment.

FIG. 16.



Exposure of tumor by cutting away skin and pectoral muscle.

Operation, December 6, 1920.—The tumor was exposed by removing the skin, fat, and the pectoral muscles on the left side, leaving a circular area six inches in diameter (Fig. 16). A mass was protruding, having already entirely destroyed the overlying ribs by pressure. A portion of the tumor, about five ounces, was removed, but the largest part had to be left in as it was tightly adherent to the surrounding structures (see Fig. 17).

The wound was packed with gauze—no sutures whatever were used to reduce the size of the opening. Radium treatment was begun on December 9, 1920, by introducing a 50-milligram capsule within the deepest recess of the tumor mass, and three radium needles of 12½ mgr. each were inserted directly into various parts of the tumor mass. The total dosage of the first treatment was 800 mgr. This was followed in quick succession by the following applications:

December 10	400 Mgr. hours
December 13	600 Mgr. hours
December 28	650 Mgr. hours
January 3	600 Mgr. hours
January 10	1050 Mgr. hours
January 16	550 Mgr. hours

— Total 3850

Total 3850 Milligram hours all inserted in the tumor mass.

The effect of the radium was mostly local. Only on January 12 we noticed a rather pronounced toxæmia which passed over in a few days; but the local effect was pronounced. The tumor was beginning to slough, assuming a grayish color and in places being almost black. The borders of the tumor became well defined in contrast to the normal structures surrounding the tumor.

This is illustrated in the frontispiece. The distinct sloughing character of the tumor in contrast with the normal and healthy appearance of the tissues around it proves the statement I previously made in this paper that cancer cells succumb more quickly to the radium than the normal cells.

The illustration in this case is most convincing. The tissues belonging to the body proper have a healthy looking appearance and do not seem to have been affected by the radium, although it has been applied in considerable doses, while the tumor itself which was as fleshy in appearance at the time of operation, is now a mass of grayish-green tissues resembling an enormous core of a carbuncle.

Comment.—It is doubtful whether the tumor will ever entirely disappear—and the physical condition of the patient is not as good as it was before the operation. The toxæmia and the frequent rise of temperature after the radium application are retarding the recuperation; but the case is here illustrated only as a guide to the direction in which we must work in order to finally succeed in similar cases.

The entire shoulder girdle should have been removed at the start so that the larger portion of the tumor might have been removed or at least so that the larger part might have been exposed to the radium treatment.

Final report of the case will be given in due time.

The microscopical section of the tumor shows a finding of *round-cell sarcoma*.

SARCOMA OF FEMUR—BUTCHER'S AMPUTATION—RADIUM TREATMENT

On November 5, 1920, a boy ten years of age came into the North Chicago Hospital complaining of swelling on his right leg above the knee, which started only three or four weeks before. Until then he had always been perfectly healthy—no acute disease preceded this illness; syphilis was excluded.

Stereoröntgenogram showed a condition resembling osteomyelitis of the lower part of the femur. Sarcoma was not suspected.

An operation was performed November 10, 1920, exposing the femur; but instead of pus we found a granulomatous tissue surrounding the lower end of the femur and invading the bone. A large sequestrum about three inches long was present. The bone cavity was cleared of its granulomatous contents—the sequestrum removed and two skinflaps inverted which were prepared so as to leave the cavity open for later radium treatment (see Fig. 18). Stereoröntgenogram, Fig. 19, shows the amount of tissues removed and illustrates the condition of the bone after the operation.

The tumor began to grow rapidly after the operation so that within a week the granulomatous mass protruded out of the cavity and hemorrhage occurred during each dressing. It was, therefore, decided to perform an amputation in the upper third of the femur.

Second Operation (December 10, 1920).—Amputation was made without any preparation of skin flaps to cover the stumps, but the bone was cut about three inches higher than the division of the muscles of

FIG. 18.



Removal of lower end of femur preparatory to radium treatment.

FIG. 19.



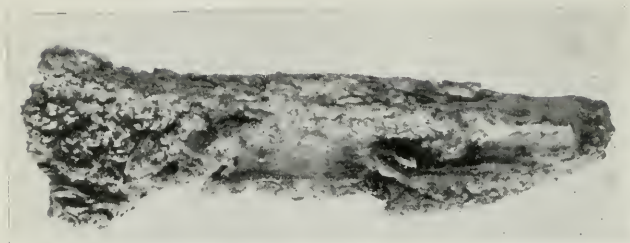
Condition of bone before and after operation. (a) Note calcified areas surrounding the femur—condition resembling osteomyelitis. (b) Removal of two-thirds of thickness of femur including sequestrum.

Fig. 20.



Butcher's amputation of limb ready for radium application.

Fig. 21.



Illustrating size of sequestrum present within the femur resembling osteomyelitis.

the thigh. The edges of the muscles were drawn together over a rubber tube which was inserted for the purpose of later insertion of the radium. The skin was temporarily fastened with four silkworm sutures, but these were not drawn tight; they were simply fastened to hold the skin from retracting too far from the stump. These were removed twenty-four hours after operation.

A day after the operation the patient developed a temperature of 104° and a deep scarlet rash. For a time it was suspected that scarlet fever had complicated the case, although the patient had been confined to the hospital for a month and, therefore, could not have been exposed to any contagious case. In a few days the fever subsided and the rash disappeared.

Radium Treatment.—December 19, 1920, a 50-mgr. capsule was inserted within the rubber tube underneath the muscles in the stump (see Fig. 20). At this time the wound was still widely gaping and no attempt was made to reduce its size. The following dosage has been applied thus far:

1920, December 19, 50 Mgr. $7\frac{1}{2}$ Hrs. 375 Mgr. Hrs. applies in stump rubber tube.
1920, December 28, 50 Mgr. 8 Hrs. 400 Mgr. Hrs. applied in wound capsule in tube.
1921, January 3, 50 Mgr. 8 Hrs. 400 Mgr. Hrs. applied in wound Scr. L2 C2 R2.
1921, January 17, 50 Mgr. 9 Hrs. 450 Mgr. Hrs. applied in wound Scr. L2 C2 R2.

The wound began to contract and the patient's general condition improved, and at present there is a small area of still denuded skin, but perfectly healthy in appearance.

The surgical treatment in this case differs from the usual method of amputation of sarcoma in that we left the stump exposed, thus making it possible for the radium to come in direct contact with the raw surfaces and also within the tissues of the stump.

Microscopic examination of the specimen proves it to be a *round-cell sarcoma*—very malignant in character. The sequestrum is illustrated in Fig. 21.

The specimen of the limb (Lumiere B) shows the entire destruction of the lower end of the femur.

Stereoröntgenogram of the lungs shows a perfectly clear lung. No metastases.

A final report of this case will be given later.

It is useless at this time to draw conclusions from a small series of

cases. At least three more years must elapse before we can make a report of a sufficiently large series, allowing ample time to know in how many recurrence had taken place.

At this time we can only state that we are not discouraged. In every case in which improvement occurred there was an actual gain, because, with the exception of only three cases, everyone submitted to this treatment was considered hopeless from the outset.

Our mortality was naturally very large on account of the extensive operations which had to be undertaken and also on account of mishaps and which might be avoided in the future. Four of our cases died of acute hemorrhage due to ulceration of the large blood-vessels; one from the femoral; one from the axillary, and two from the carotid. The hemorrhage was due to ulceration of the blood-vessels from placing the radium needle in too close proximity to the vessels. Four cases died as a result of Röntgen ray toxæmia.

On the other hand, we have a number of cases which have stood a reasonable test of time. A case of carcinoma of the breast is still without recurrence two years after the last operation. One case of carcinoma of the submaxillary gland in which three radical operations preceded the last (which was the open method), has had no recurrence for two and a half years, and is in perfect health.

There are a number of cases which have stood the one-year test. A number have been too-recently operated, are still alive, and we cannot yet make any comments on them. For the present then we can only say that we are encouraged but not entirely satisfied. We have, however, gained the conviction that we have injured no one and benefited a few.

I am sure that in the discussion the point will be brought up that in using radium emanations instead of radium salts, the operative treatment may be omitted because the fine glass tubes introduced into the tumor itself will eliminate the objection set forth: namely, the filtering of the rays by overlying tissues. Since emanations are not always available, and this is the case in probably 90 per cent. of the cases treated with radium in the United States, the method here advocated will have its place in cancer therapy.

A SURGICAL CLINIC

AT THE MEDICO-CHIRURGICAL HOSPITAL

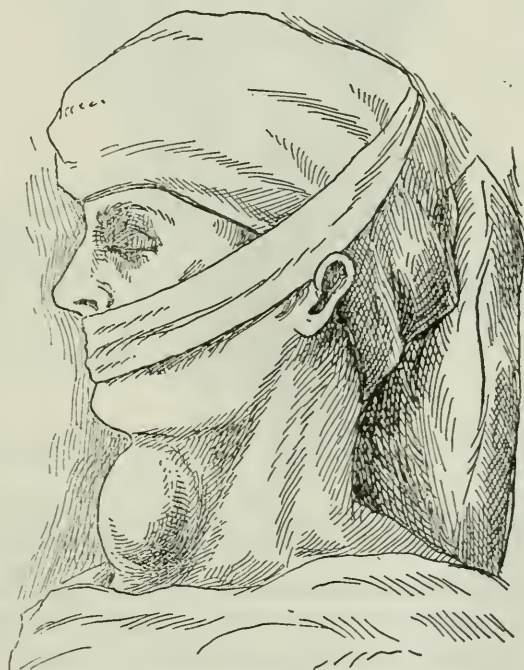
By P. G. SKILLERN, JR., M.D., F.A.C.S.

Associate Professor of Surgery, University of Pennsylvania Graduate School,
Philadelphia

CYSTIC GOITRE; THYROIDECTOMY UNDER LOCAL ANÆSTHESIA

THE writer is one of those who for many reasons feels that local anæsthesia is superior to general for operations upon the thyroid gland. The following case is an example of the removal of a large cystic goitre by this method.

FIG. 1.

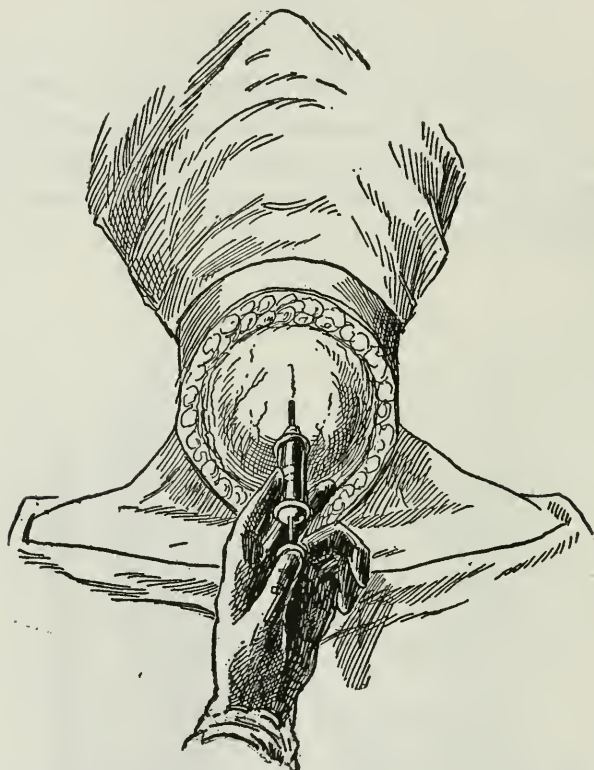


Appearance of tumor *in situ*.

M. H., female, aged forty-one, widow, was admitted to hospital on November 14, 1920; discharged cured on November 22, 1920. The patient states that for twenty years she has had a swelling in the

front of the neck; this swelling, however, caused no trouble until six years previous to admission when, after a period of worry, it began to enlarge. She has occasional attacks of pain in the region of the enlargement, whereupon her heart begins to flutter. Her digestion is not always good, and she is constipated. She had an attack of ton-

FIG. 2.



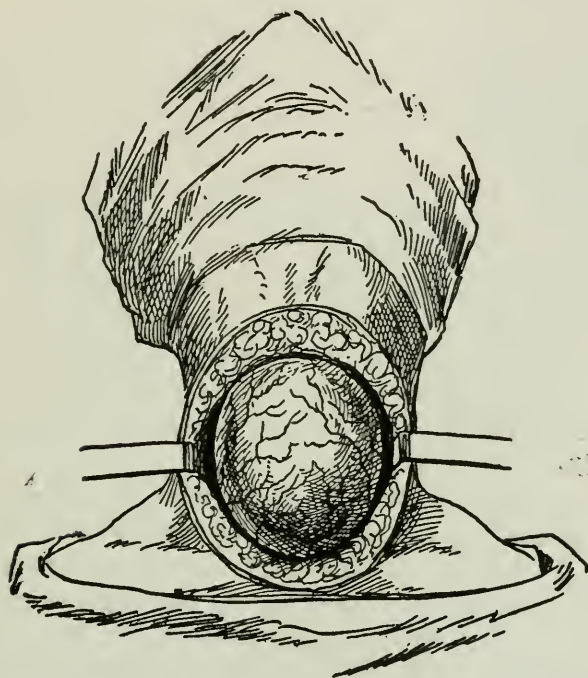
The line of the collar incision has been infiltrated intradermally with procaine, and the skin, superficial fascia and platysma have been divided. Subfacial infiltrations are being made in the midline.

silitis ten years previous to admission. Physical examination reveals a firm, smooth enlargement of the thyroid gland extending from one sternomastoid to the other (Fig. 1). There is no exophthalmos or tachycardia, nor are there any tremors.

Operation (November 15, 1920).—Morphin-hyoscin preliminary narcosis; local infiltration anæsthesia, using novocaine 1 per cent. solution. Transversely curved "collar" incision from posterior bor-

der of sternomastoid of one side to same of opposite side, lowest point of convexity reaching to 1 inch above sternum (Fig. 2). Skin and superficial fascia with platysma divided; anterior jugular veins ligated and divided: this superficial flap was reflected up to hyoid bone, and then midline subfascial infiltrations were made (Fig. 2). Anterior layer of deep cervical fascia divided in midline. Infra-

FIG: 3.



The cervical fascia has been split in the midline, the right infrahyoid muscles have been divided and retracted, and the goitre has been displaced into the operative field.

hyoid muscles (except omohyoid) clamped below hyoid bone and divided between clamps. Enlarged right lobe of thyroid displaced forward (Fig. 3); isthmus divided; superior thyroid vessels clamped (Fig. 4), ligated and divided; posterior portion of capsule freed from lobe and left *in situ*; inferior thyroid vessels clamped, ligated and divided. There were two separate swellings involving the right lobe, and these were removed, leaving a remnant of the lobe posteriorly in relation with the capsule (Fig. 5). Isthmus stump oversown. Divided anterior cervical fascia closed, except below, where cigarette

drain was placed down to trachea. Skin and superficial fascia closed with continuous horsehair except at drainage site. Gauze dressing applied.

Postoperative Notes (November 17th, two days after operation): Cigarette drain removed.

November 22d (one week after operation): Suture removed; healing *per primam* throughout.

FOREIGN BODY (STEEL) IN THIGH; REMOVAL

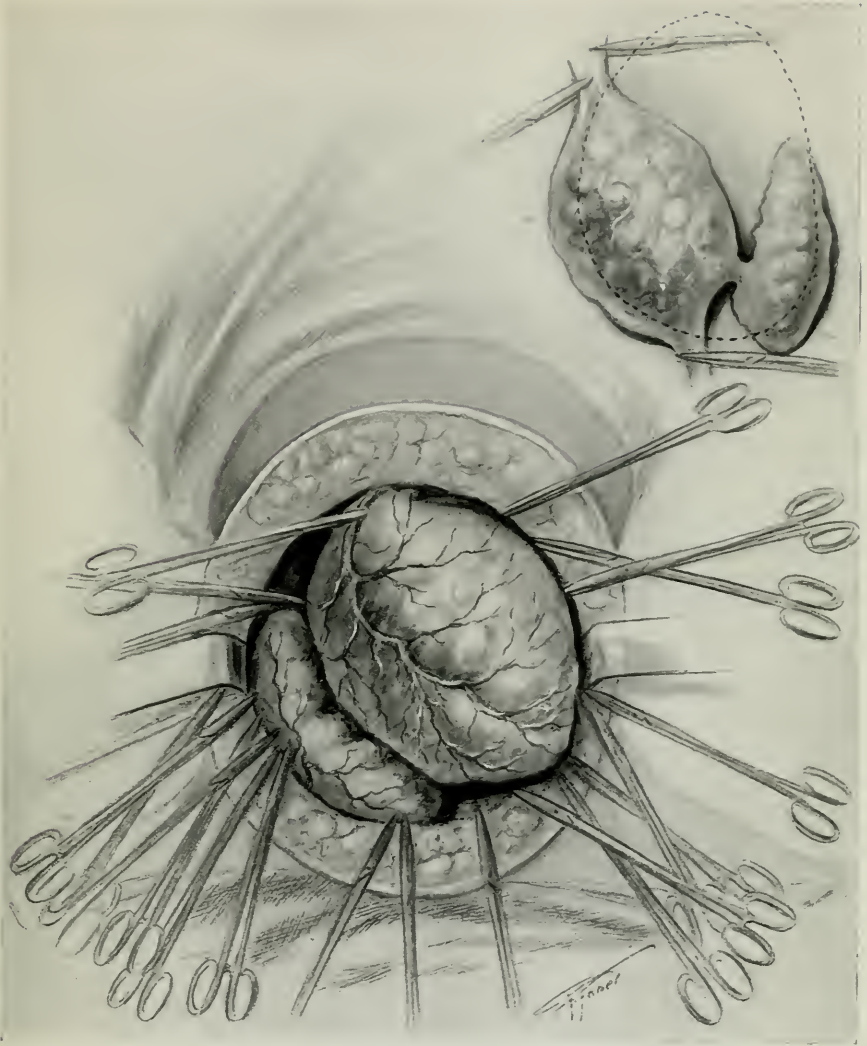
The following case illustrates how the removal of a foreign body from soft tissues can be facilitated by searching in a definite, systematic manner.

A. M., male, aged twenty-five, carpenter, stated that in September, 1920, a piece of steel about the size of a split 22-calibre BB shot was driven into his right thigh on the inner side. Shortly after the accident he was operated upon elsewhere three successive times, but the foreign body was not found. He suffers from knife-like pains in right leg posteriorly, up and down the midline. The location of the referred pain is suggestive of irritation of the small sciatic nerve. The skiagram (Fig. 6) gives the approximate location of the body in relation to the surface.

Operation (April 2, 1921).—Under ether anæsthesia a vertical incision 5 inches long was made over the inner portion of the thigh just below the middle, dividing skin, superficial fascia and fascia lata, the edges of which were retracted, exposing the muscles and intermuscular septa. Systematic search was now begun, the intermuscular septa first being examined. Soon the operator came to the interval between the semimembranosus and semitendinosus muscles, and on separating these muscles from each other the piece of steel was encountered between them and just deep to the plane of the fascia lata. The body was enveloped by a thin connective-tissue capsule, but before removing it its juxtaposition with a branch of the small sciatic nerve was established. The piece of steel was now removed. The edges of fascia lata were approximated with interrupted sutures of plain No. 2 catgut, while the skin was closed with interrupted silk-worm-gut sutures. Rubber-dam drainage was established through a stab wound made posteriorly, at the most dependent point.

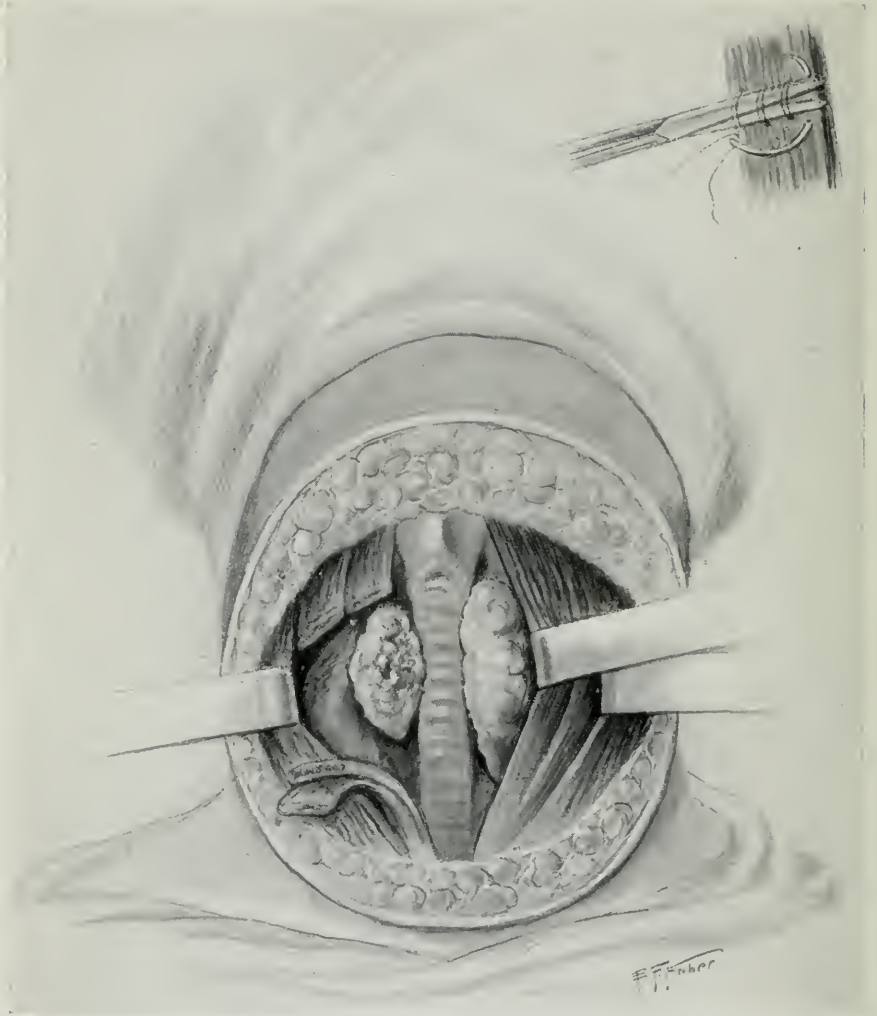
Postoperative Notes (April 3d).—Rubber-dam drain removed.

FIG. 4.



The enlargement of the right lobe is due to two separate tumors. The superior thyroid vessels are being clamped.

FIG. 5.



The right lobe and isthmus have been resected, leaving a remnant posteriorly in relation with the posterior capsule. The method of suturing the infrahyoid muscles is shown.

FIG. 6.



Lateral view of thigh showing foreign body in relation to pins placed upon the surface. At operation the body was found lying between the semimembranosus and semitendinosus.

April 4th: Patient states that he feels fine and that he has been relieved of all symptoms.

In a paper by the author, entitled "On the Extraction of Needles from Tissues," which was published in the *Interstate Medical Journal*, vol. xxii, No. 3, 1915, a definite, systematic plan of searching for these foreign bodies was described. This method depends upon the rigid observance of four rules. In the first instance, the field should be *absolutely bloodless*. Secondly, *follow the black track* which leads from the skin puncture to the needle: the success of this step is dependent upon that of the first. The third is *efficient retraction of tissues*. The fourth rule is to *lose no time in searching in the fat*, since the needle travels directly to deep fascia or bone, the subcutaneous fat being too soft either to stop or break it. The mechanism is, that at the instant of impact of the needle against the tissues the elastic fat is compressed and the needle is driven into and caught in a strong grip by the dense palmar or plantar fascia or bone, and that when the pressure is released the elastic fat springs back into place and swallows up the needle, as it were.

With the patient properly anesthetized, a free incision is made directly down to the deep fascia. The length of the incision varies directly with the depth of the subcutaneous fat. In some cases time is gained by adding another limb so as to fashion a T-incision, and often even a crucial incision is necessary. The incision is so placed as to include the skin puncture made by the needle, and the black track is exposed and followed to the deep fascia. The latter is thoroughly exposed by retracting the flaps. The needle is usually found sticking into the deep fascia, but if it has penetrated more deeply, this fascia must be incised and retracted. The underlying muscles or tendons are examined each in its own plane.

This method of *plane dissection* is very important. If the needle is not in one plane, it must be in some other, and each plane must be successively explored. The bones form the last plane, and by the time they have been reached, the needle has probably been found. It is carefully extracted by traction *in its own axis*, for it is liable to break. Before each plane is dissected it is palpated with the tip of the little finger, or explored by the handle of the knife, which may scrape against it. These latter are invaluable methods of detecting the needle.

By following this plan, the usual causes of failure—namely, too small an incision and insufficient retraction, will be eliminated, and, to the contrary notwithstanding, it is not always essential to have a skiagram for guidance.

In our text case, however, we were dealing with the thigh, which resembled the proverbial haystack, so that a skiagram was very necessary and proved to be of great assistance. It was only because this small foreign body was irritating a nerve that the operation for its removal was performed: had it penetrated an intermuscular septum and lodged in a muscle it in all likelihood would not have made its presence manifest. There is no harm in searching a muscle for a foreign body, however, so long as the muscle fibres are separated in the direction in which they run and not cut across.

EPITHELIOMA OF VULVA: VULVECTOMY; INGUINAL LYMPHADENECTOMY,
USING LOCAL ANÆSTHESIA

This patient, only thirty-two years of age, had had for two years a growth on the right labium majus. It began as a small spot which gradually and progressively increased in size. Physical examination revealed the labium occupied by an ulcerating growth the size of the palm of the hand. The fingers could be gotten behind this growth, however, between it and the superficial perineal interspace, showing that there was a surgical pedicle of sound tissue, instead of infiltrating fixation of the growth to the deep parts. The inguinal lymph-nodes on the same side formed a racemose mass the size of an apricot. Rectal and vaginal examinations did not reveal metastases to the lymph-nodes in the pelvis. The uterus was free from disease.

Operation (March 22, 1921).—Morphin-hyoscin narcosis. Local anaesthesia, using 1 per cent. solution of novocaine. First, a block dissection was made of the inguinal lymph-nodes. Then unilateral vulvectomy was performed, the dissection being carried wide of the tumor, through apparently uninvolved tissue. The edge of the vagina was mobilized and sutured to the skin edge, which had retracted to the lateral recess of the perineum, using interrupted sutures of silk-worm-gut. It was necessary to pack a portion of the wound with a gauze tampon, in order to control oozing from the floor of the wound: this pack was retained by silkworm-gut sutures. A vulvar pad was applied and retained by a muslin T-bandage.

Epithelioma of the vulva is not a common ailment and is infrequent in a patient in the early thirties. According to Graves it is extremely malignant and metastasizes early to the inguinal lymph-nodes, and thence to the nodes of the iliac system. Among the conditions that could be mistaken for epithelioma of vulva are lues (in early stage), esthiomene, elephantiasis, tuberculosis, and condylomata acuminata. The treatment is vulvectomy and removal of involved lymph-nodes. Graves states that most of these cases come to operation late, and that on account of the tendency to early metastases the prognosis is unfavorable, as a rule. In inoperable cases radium may be of service.

HAMMER-TOE: STRAUS' (MODIFIED JONES') OPERATION,
USING NOVOCAINE

In hammer-toe that has reached the operative stage amputation is still considered in many quarters to be the routine treatment, although such an authority as Sir Robert Jones states that amputation should never be done, the reason, of course, being the liability to the development of hallux valgus after removal of the second toe, which deformity may be more crippling than that of hammer-toe. This tendency was manifest in the writer's case, which, while posted in the operation book as merely "Hammer-toe," yet was reported to the Daily Surgical Bulletin by the house doctor as "Amputation for Hammer-toe."

The patient was a young adult male who went up for enlistment in the navy but was found disqualified by the hammer-toe deformity and was referred to the writer for operation. Local anaesthesia (novocaine 1 per cent.) was used both for infiltrating the tissues and blocking the musculo-cutaneous and anterior tibial nerves. The operation was essentially that of Jones as modified by Straus, of Chicago ("Surgical Clinics of Chicago," October, 1917, pp. 1090 to 1095). An elliptic incision was made enclosing the clavus at the summit of the hammer-toe and was deepened to the bone, dividing the extensor tendon of the digit. After freeing and retracting the soft parts the interphalangeal joint was resected by a wedge-shaped excision, as Jones recommended. The lateral ligaments and posterior capsule were divided: it was not necessary to divide the flexor tendon because the toe could be straightened without doing so and, as Straus

states, this tendon will act somewhat as a splint, so that the joint will not be too flail-like. The extensor tendon was sutured with chromic catgut, and then sutures were passed through the adjacent fibrous tissue and periosteum in order firmly to appose the freshly sawn bone surfaces. The skin edges were apposed with interrupted sutures of horsehair. A padded plantar splint was applied. The patient was sent home and told to present himself for examination at the end of three weeks.

When the stitches were removed—twenty-one days after operation—it was found that primary union had taken place, both of bone and of soft tissues. The toe was somewhat shorter than before operation—about the same length as the fourth toe—but it was straight. Recurrence of the deformity was prevented by the synostosis of the freshened bone surfaces, and the toe by its presence would always prevent the development of hallux valgus.

ABSCCESS OF PROSTATE: PERINEAL SECTION, USING LOCAL ANÆSTHESIA

This patient, aged twenty-two, was referred to the writer a few days after the development of acute gonorrhœal prostatitis. His chief complaint was inability to urinate, but he also complained of severe throbbing pain, which he referred to the rectum. Physical examination revealed fever (102° F.) and by rectum a plum-size enlargement of the left lobe of the prostate gland. This swelling was very tender; there was increase of local heat, and the tumor yielded somewhat to the pressure of the palpating digit (fluctuation), in contrast to the resistance of solid enlargements of the gland. Abscess of the prostate having been diagnosed, immediate evacuation of the pus was imperative, lest it should invade the perineum, or rupture into the urethra or rectum, or, if confined within the capsule of the prostate, enter the blood-stream and give rise to pyæmia.

Operation (April 16, 1921).—Morphin-hyoscine narcosis. Infiltration of line of intended incision and subcutaneous tissues with procaine, one-half of 1 per cent. solution. Incision made on left side of perineum, beginning in the median raphe just below scrotal attachment, passing obliquely outward and backward and terminating at a point midway between the tuberosity of the ischium and the anus. In the anterior portion of the wound the skin and superficial layer of the superficial fascia were divided; Colles' fascia and the base of the

triangular ligament were exposed but not opened. In the posterior portion of the wound the fore part of the ischiorectal fossa was entered, great care being taken to avoid injury to the rectum, which pouches forward at this point. A retractor placed at the base of the triangular ligament dragged forward out of harm's way the important structures in the perineal interspaces. Retracting the rectum backward the wound was deepened by blunt dissection in the direction of the enlarged left lobe of the prostate gland until the fibres of the levator prostatae were exposed: these were separated and the rectovesical layer of the pelvic fascia was incised, exposing the tumefied prostate lobe, which was found protruding slightly into the operation field. The left index was now passed into the rectum and the right index to the bottom of the wound: the swelling was thus gotten between the finger-tips so as to prove that the tissue about to be opened was the swollen prostate lobe. While the latter was steadied by the finger in the rectum the right index was removed, and a grooved director thrust through the capsule of the prostate into the abscess cavity, pus now trickling along the groove of the director. A bistoury was passed in the groove of the director and through the capsule of the prostate into the abscess cavity, making an opening about $\frac{1}{4}$ inch long. The bistoury was withdrawn, and a pair of forceps was passed into the abscess cavity closed and withdrawn opened, permitting the escape of about four teaspoonfuls of pus. The forceps was withdrawn, and the little finger was introduced into the abscess cavity so as to break down septa. The finger was withdrawn, the cavity was sponged out, and two pieces of No. 15 F. catheter were passed into the abscess cavity and surrounded by two pieces of gauze packing placed in the anterior portion of the ischiorectal fossa. The pieces of catheter and gauze were retained by a skin suture of silkworm-gut, and the anterior portion of the wound was closed up to the drainage by interrupted sutures of silk worm-gut. The abscess cavity was now irrigated through the two-way catheter, a few small blood clots being washed out of the return tube. Sterile gauze pads were applied and retained by a T.

This operation is essentially the method described by Lusk in *Annals of Surgery*, January, 1907, p. 103. It is safer than Alexander's method (*ibid.*, 1906, xiii, p. 883), whereby the abscess is opened through the prostatic urethra—a method that is rapid and excellent for late cases in which the abscess has pointed in the urethra.

DERMOID CYST OF INGUINAL REGION

This patient—a male aged thirty-five—has for eighteen years been complaining of a swelling in the left inguinal region. At first this swelling was painful and was opened by a physician under the impression that it was an abscess. It discharged pus for a time and then closed, reopening, discharging and closing several times since then.

Physical examination reveals in the left inguinal region what appears to be a direct inguinal hernia. The skin over the left pubic bone is infiltrated from infection, and there is a transverse operation scar one-half inch in length at this point. Based on the history and physical findings the diagnosis of dermoid cyst was made.

Operation (April 20, 1921).—Morphin-hyoscin narcosis. One per cent. procaine infiltration. Exposure made as for direct hernia. Cyst resembled hernia sack of "pantaloon" type, being bisected by deep epigastric vessels. Mesially it was adherent to pubic bone and conjoined tendon and appeared from beneath pubic head of rectus. The epigastric vessels were ligated and divided, greatly facilitating removal of the cyst. The latter was the size of a plum and contained hairs and infected sebaceous material. The wound was closed with drainage.

Medicine

PRIMARY SARCOMA OF THE LIVER

WITH THE REPORT OF A CASE

By HYMAN I. GOLDSTEIN, M.D.

Camden, N. J.

WHILE cancer of the liver is third in order of frequency of internal cancer, sarcoma of the liver is rare. Carcinoma of the liver is rarely primary, it is usually secondary to cancer in other organs. Primary sarcoma of the liver is very rare. Secondary sarcoma is more frequent. Many cases of secondary lymphosarcoma and myxosarcoma of the liver are on record. The most important secondary sarcoma of the liver is the melanosarcoma—usually secondary to sarcoma of the eye, skin, or suprarenals. Primary melanosarcoma of the liver is very rare.

Heaton's case of congenital round-celled sarcoma of the liver occurred in an infant girl aged eight weeks. The spleen was normal. The liver was greatly enlarged. There was a nodule in the right adrenal. The left adrenal was normal. There was no jaundice and no ascites. The liver was the seat of a diffuse, round-celled sarcoma. This case somewhat resembles Tooth's (1884) case. In Tooth's case the girl was five years old; the tumor had caused symptoms for six months. The liver weighed 48 oz. and was a primary lymphosarcoma.

In Pitt's case (February 1, 1898) the boy was ten months old. He had been wasting and vomiting, and had diarrhœa. The child became jaundiced. The right lobe of the liver was greatly enlarged and was involved by one great mass of tumor tissue. The right adrenal and the pancreas were affected with secondary tumors. It was a very vascular, small, round-celled sarcoma, primary in the liver.

DeVecchi and Guerrini, of Bologna, Italy, in 1901 reviewed the literature on primary sarcoma of the liver. They report twenty-three undoubted cases (including two of their own) of primary hepatic sarcomata; twenty of the reported cases they classify as doubtful,

seven other cases they have not examined. Up to November, 1901, there have been about fifty cases of probable primary sarcoma of the liver recorded in the literature. Of these thirty are without doubt true primary tumors of the liver.

Thomas R. Crowder (November 13, 1899) reported an interesting case before the Chicago Pathological Society, that was probably one of pseudoleukæmia, with generalized tuberculous lymphadenitis—similar to Troje's, Sternberg's, Cordua's, Courmont's, and Dietrich's case.

The liver was moderately enlarged and contained a number of firm nodules of lymphoid character. These lymphoid nodules were present also in the lungs and spleen. The pancreas was apparently normal, but was surrounded by many large lymph-nodes. The vermiform appendix and the suprarenals were not involved. The patient was a lumberman (John A.), aged thirty-four years, in the Presbyterian Hospital Service of Dr. N. Senn.

LeCount's case was a man fifty years of age. In this case there was diffuse sarcomatous infiltration of the liver with widely scattered metastatic tumors secondary to sarcoma of the eye. Sarcomata were present in the pancreas, liver, thyroid, mediastinal and retroperitoneal lymph-nodes and also in the mesentery, stomach and gall-bladder. The liver weighed 5360 gms. There were six small sarcomatous nodules on the inner surface of the stomach. A large sarcoma in the mesentery of the transverse colon had invaded the tail of the pancreas. The walls of the duodenum were thickened and in the tissue around the duodenum there were numerous small sarcomatous nodules. The appendix was 7 cm.; thickened walls, and contained a fecal concretion.

Hektoen and Herrick wrote on this subject in the *American Journal of Medical Sciences*, 1898, cxvi, 255.

Rolleston reported a case and collected thirty-six cases of melanotic sarcoma of the liver from the literature, and found that in twenty-four of these cases the primary tumor was in the eye (Rolleston, *Lancet*, 1899, i, p. 1273, London).

N. W. Jones showed three specimens of sarcoma of chicken livers before the Chicago Pathological Society, April 10, 1899.

Ludwig Hektoen (April, 1896) reported a case of spindle-celled sarcoma of the liver, in the form of multiple nodes and nodules secondary to a sarcoma of the eyelid removed four years before death. The

man was sixty years of age. The liver weighed 18 pounds. Tumors were found in the pancreas, kidneys and retroperitoneal region. It was composed of a medium-sized spindle-celled sarcoma. His second case was a diffuse infiltrating melanosarcoma of the liver, secondary to melanosarcoma of the eye. The patient was a man, aged fifty, a manufacturer. September, 1895, Doctor Holmes diagnosed the tumor of the right eye as melanosarcoma of the choroid. The patient died December 7, 1895. The post-mortem was made one hour after death. There were metastatic tumors in the left kidney, lungs, pleuræ and liver. Pancreas was normal.

Birch-Hirshfield reported a case of melanotic sarcoma of the liver, which followed seven years after the eye operation. There was a diffuse pigment sarcoma of the liver.

Hektoen's third case (April, 1896) was a case of primary, large, round-celled sarcoma of the left lobe of the liver in a harness-maker. He was admitted to the Cook County Hospital September 24, 1895, and died October 2, 1895. Clinical diagnosis was tumor of the pancreas. Anatomic diagnosis—tumor (primary) of the left lobe of liver, secondary tumor nodules in the tail of the pancreas, mesentery, omentum and spleen; thrombosis of dural sinuses and of the inferior vena cava, etc. Thyroid gland normal. Except for the tail, the pancreas is normal; the hen's-egg size, firm nodule situated above the tail, is distinct from the latter. There is a small tumor mass underneath the capsule, otherwise the spleen is normal. The gastro-intestinal tract is normal. The tumors consist of large, round cells with deeply staining, rather small nuclei. The cells are imbedded in a fibrillated vascular stroma which separates the individual cells. Evidently the sarcoma originated in the perivascular connective tissue of Glisson's capsule in the liver.

Hektoen states that while "the liver is the most frequent seat of secondary sarcoma next to lungs, primary sarcoma of the liver is very rare." Arnold, in 1890, reported two cases, because he thought up to that time that primary sarcoma of the liver did not occur. He was able to collect twenty-six cases from the literature which were reported as primary. The pigment sarcoma is almost always secondary in the liver. Hanot and Gilbert exclude all the instances reported as primary pigment (melanotic) sarcoma of the liver, but one.

Beadles's (April 4, 1899) case was a man aged sixty-four years.

He had a round-celled sarcoma, involving the region of the pancreas, liver, suprarenals, and left lung. The liver was enormously enlarged, containing small, round sarcomatous deposits. In the region of the pancreas a large tumor mass, which presumably originated in the lymphatic glands around the pancreas and small curvature of the stomach.

Beadles thinks the site of origin of the growth in his case is probably in the right suprarenal body, or in the lymphatic glands, about the base of the liver and head of the pancreas.

In Thomson's (April 21, 1899) case, the man was aged forty-nine years, a painter. His big toe was amputated for melanotic sarcoma three years ago. He then developed a large, rounded mass in the left hypochondrium, and he complained of constant nausea, constipation, anæmia, pain and tenderness all over the abdomen. At post-mortem, Thomson found a large cystic mass containing two pints of dark brown fluid, between the folds of the small omentum, under the surface of the left lobe of the liver and under surface of diaphragm. There were twenty large secondary growths in the small intestine, involving the duodenum, also cæcal region, and upper part of jejunum. All these nodules grew into the lumen of the bowel, there were no symptoms practically referable to the small bowel, and finally the liver, stomach, appendix, pancreas and all other organs were free from metastatic involvement, all the sarcomatous masses being limited to the small intestine.

Herzog and Harris reported a case of lymphosarcoma of the mesentery, operated on successfully in a boy of five years; at that time (1897) they were able to collect a total of fifty-seven cases of solid mesenteric tumors, of which ten were sarcomata. They reported another case of mesenteric lymphosarcoma January 10, 1899, before the Chicago Pathological Society in an old German physician, aged sixty-two years.

The case of the boy was first seen by Doctor Harris in April, 1896. A large tumor, easily palpable, was found to fill the greater portion of the abdominal cavity. A diagnosis was made of solid tumor of the mesentery and the patient was operated on April 13, 1896. The tumor and 51 cm. of jejunum were removed. Ten months after the operation he was in excellent health and without any signs of recurrence. Histologically the tumor proved to be a lymphosarcoma, with extensive colloid degeneration.

The other case, the physician, about six years before, discovered a moderate glycosuria, which disappeared, on a course of Carlsbad treatment. Ailing about two months. Complains of weakness and dyspnoea and of increasing size of abdomen. Clinical diagnosis—*atrophic cirrhosis of liver*, because of the ascites and palpable spleen. Patient was tapped. Diagnosis changed later to probable carcinoma. Chylous ascites, due to obstruction of thoracic duct by the tumor. The post-mortem was made fifteen hours after death (October 16, 1898). The mesentery, omentum, pancreas, retroperitoneal glands, the liver, the *pluræ*, the bronchial glands and the lymphatic glands on the neck of the gall-bladder were all involved, the primary growth being in the mesentery. The tumor masses in the mesentery, omentum, head of pancreas, in the lungs, and in the inguinal glands, are all of the same structure. They consist of small, round cells of the type of the ordinary small lymphoid cell. The nuclei are quite rich in finely granular chromation, the cell protoplasm very scanty. The stomach and kidneys are normal.

De Haan (1903) reported an *alveolar angiosarcoma* of the liver in an infant aged four months. There were no secondary tumors. The illness began when the baby was two months old, with pyrexia and enlargement of the liver. In the Pathological Museum of St. Bartholomew's Hospital there is a specimen of primary round-celled sarcoma from an infant aged two months.

Baumann and Forbes' case (Doctor Penrose) was a boy aged eleven months, treated at the Hospital for Sick Children (December 4, 1903). Baby was ailing for a month. Had "swelling of the belly"; was not jaundiced. Operation December 9, 1903. Died three days later. The liver was much enlarged, massive tumors of round and spindle-celled sarcoma. There were no metastases. It may have been *angiosarcoma*.

Bramwell and Leith (1897) have been able to collect only twenty-seven cases of primary sarcoma of the liver; the great majority of these were in adults, only one or two cases being in children. The post-mortem records of the Hospital for Sick Children from January, 1860 to 1904, furnish but a single other instance of the occurrence of primary sarcoma of the liver in a child three years old. According to Baumann and Forbes (1904) the whole literature comprises only four authenticated cases in infants under twelve months of age.

West (1884) reported a case of medullary sarcoma of the right lobe of the liver. Secondary nodules were present in the right lung. The male baby was aged eight months, and he was ailing his whole life.

Meisenbach's (1884) case was an infant four months old. Child was sick ten weeks. It was a myosarcoma of the liver with secondary metastases in the lungs.

Lendrop's (1893) patient was an infant aged four months. The liver contained numerous disseminated tumors of small round cells which seemed to originate in the endothelium.

Rothrock's case (September 26, 1889) occurred in a salesman aged thirty-four years. Liver weighed $9\frac{1}{4}$ pounds. No other metastatic growths except eight masses surrounding the pancreas. No growths in the eyes, brain, testicles, stomach or intestines.

The cases of sarcoma of the liver reported by Pepper, Lee, Kohlman and White are considered to be carcinomata by Vecchi and Guerrini, Henschen's case is considered to be a cystic telangiectatic carcinoma.

Vecchi and Guerrini exclude from their list the cases of Wagner, Ledue, Pellacini, Frehrichs, Block, Parker and Burnett, because sarcomatous nodules were found in other parts of the body, as the eyes, skin, spinal cord and intestines, etc. Lancereaux's case is thought to be one of fibroma. They exclude the cases reported by Warren, Warshawski, Hutyra, McKee, Axtell, Knoch, Krasnobajew—because they were unable to verify and investigate the reports.

Their list of primary sarcoma of the liver includes the cases of Lancereaux, Maffucci, Walch, Hoerup, Podrowzek, Rehn, Pintray, Windroth, Elepine, Arnold (two cases), Byrom, Steinhaus, Dionisi (two cases), Pepere (four cases), Cesar Demel and Hohlden, a total of twenty-one cases, and with the two cases they report makes twenty-three.

Among the twenty "doubtful" cases of primary hepatic sarcomata are listed the cases of Ruyter, Kummel, Israel, Henschen, White, Burnett, Tooth, Messenbach, Parker, Pellacini, West, Frehrichs, Wagner, Naunyn, Roberts, Lee, Pepper, Koltmann, Block and Ledue.

Vecchi and Guerrini (1901) report one case in a man fifty-eight years old. They called it sarcoma magnicellulatum polymorphum. The second case was a man aged sixty-six years. The tumor consisted

of accumulations of small, fixed cells, with large cells toward the centre. Signs of necrosis and mononuclear giant-cells are rather abundant. In places the tumor, in fact, appeared like a cavernous angiosarcoma. In these two cases the liver was evidently cirrhotic; they are persuaded to consider the neoplastic tendency to be attributable to a preceding cirrhosis and they give their reasons for this opinion.

Starr (1917), de Ahna (1912), and Swenson (1917) reported cases of hypernephroma of the liver.

W. Scott Lang (1889) reported a case of primary sarcoma of the liver in a woman aged fifty-seven years. She complained of a swelling or lump in the abdomen. She lost some flesh. Began to have pain below right breast two months ago. There was marked ascites, no jaundice. The liver weighed $13\frac{1}{2}$ pounds and contained several large nodular masses. They were soft and semi-fluctuating. It was a round-celled sarcoma (p. 904, April, 1889, *Edinburgh Med. Jour.*, xxxiv, Pt. ii, January-June).

Wm. J. Mayo and Chas. H. Mayo, in Keen's "Surgery," iii, p. 985, state: "Primary sarcoma of the liver is more rare than carcinoma. No case in which operation has been done has been reported. The lesions of congenital syphilis may be mistaken for the disease. It usually occurs as a massive tumor, a diffuse infiltrating form. The secondary growth in the liver is much softer than carcinoma, sometimes has a cystic or pulsating feeling; it is much more rapid in growth, especially the melanosarcoma."

Primary carcinoma of the parenchyma of the liver is rare.

Primary carcinomata of the bile passages are very rare.

Primary carcinoma of the gall-bladder is chiefly seen in old age.

Tiedemann says that sixty is the average age for carcinoma of the gall-bladder.

Lecchtenstern states primary carcinoma of the liver occurs in younger patients, the average being below forty.

My case, John Y., was aged thirty-eight years.

G. Hoppe-Seyler (1903) says: "The rare cases of primary sarcoma of the liver that have been reported are usually seen in persons still younger than those afflicted with carcinoma; they are seen more frequently in childhood."

Hoppe-Seyler (Kiel) mentions the primary sarcomata of the liver

reported by V. Kahlden, Waring, Windrath, Arnold, Horup, Lance-reaux, Bock (primary melanosarcoma), Belin (primary melanosarcoma), Frehrichs, Bramwell and Leith, Axtell and West.

Sklifosowski removed a pedunculated sarcomatous fibromyoma of the liver. Williamson (*Lancet*, December 2, 1900) reported eleven cases of melanotic sarcoma of the liver, in three of which melanogen was twice found in the urine. Hamburger also reports two cases of melanosarcoma of the liver (secondary to eye tumor); he found melanin in the urine of these cases.

Morrow and McKinstry's (September, 1919) case of primary sarcoma of the liver occurred in a man aged forty-two years. He was very emaciated. Illness dates back about a year. Slight grade of secondary anæmia present. Blood: Wassermann was negative. The stomach, pancreas, intestines, kidneys and adrenals were normal. The liver, the lungs, and enlarged lymphatic glands were the seat of sarcomatous tumors.

The tumor was composed of small, round and spindle-shaped cells. Blood-vessels were scanty and ill-formed. They state primary sarcoma of the liver is a decidedly rare growth. They mention the fact that Hale-White, in 1890, stated that not a single case was met with at Guy's Hospital during the twenty years (inclusive 1870-1889); and quote Vecchi and Guerrini's list of forty-five cases, with only twenty-one accepted, and Rolleston's (1912) list of thirty-two cases (collected) in adults. They also note Bramwell and Leith's series (1897) of twenty-five cases, and Pepere's (1902) tabulated list of forty-five cases.

In Harger's case of primary sarcoma of the liver (February, 1919) no autopsy was permitted. Burmeister reported the growth to be lymphosarcoma of the liver, with complete destruction of all the liver tissue with the exception of the bile-ducts. No other focus of neoplastic disease had manifested itself.

I. CASE REPORT

PRIMARY SPINDLE-CELL SARCOMA OF THE LIVER

U. P. Autopsy Records.—No. 63, 1913 (Blockley Hospital, April 29, 1913).

August 1, 1913: No. 4178 (Histological Records, Univ. of Penna. Path. Labs.).

Mr. Charles K., white, male, aged thirty-eight years. This patient was in the service of Doctor Ashton at the Philadelphia General Hospital (Blockley). He was admitted to the hospital March 29, 1913, and died April 29, 1913, 2 A.M. Doctor Lynch performed the autopsy, fourteen hours after death.

Clinical Diagnosis.—Multiple tuberculous serositis.

Gross Anatomical and Histological Diagnosis.—Lungs and Heart:

Lungs: Chronic apical tuberculosis and hypostatic pneumonia (gross).

Heart: Chronic aortic and mitral valvulitis, acute vegetative aortic endocarditis.

Chronic fibrous epicarditis, myocarditis and endocarditis, parenchymatous degeneration of the heart; croupous pneumonia, chronic fibrous pleurisy, and œdema of the lungs, chronic passive congestion.

Spleen: Chronic fibrous capsulitis, chronic interstitial splenitis with passive congestion. Acute splenic tumor. Weight, 250 gms.

Kidney: Chronic interstitial nephritis (arteriosclerotic type). Bilateral hydronephrolithiasis. Right kidney, 170 gms. Left kidney, 200 gms.

Liver: Spindle-celled sarcoma arising from the wall of a chronic abscess. Chronic fibrous capsulitis, acute fibrinous and organizing capsulitis, organizing abscess, parenchymatous and fatty degeneration, early portal cirrhosis.

Pancreas: Parenchymatous degeneration. Normal size arteriosclerosis.

Chronic fibrous serositis, peritoneum, pleura and pericardium. Liver weighs 1650 gms., 35 x 19 x 8 cm. Abscess cavity on under surface of the left lobe.

Capsule is enormously thickened.

One portion of the section from abscess wall is composed of masses of young, spindle-shaped cells, running in an irregular fashion, practically no intercellular substance, with active hyperchromatic and mitotic nuclei, large numbers of endothelial-lined blood channels, there is no capsule. Penetrating directly in the inner portion of the section is a mass of young and old fibrous connective tissue, well-formed congested blood-vessels, and one portion of the section shows extensive degeneration and necrosis.

The spindle-celled sarcoma is primary in the liver in this case. No metastases present anywhere else in the body.

G. W. Hunter (1911) reviews the subject of "Sarcoma in Infancy and Childhood." He states sarcoma of the liver must be exceedingly rare as record of only a few undoubted instances can be found. He was able to find (less than) 100 cases of gastric sarcoma recorded, the majority of which were in adult life. He mentions Finlayson's case in a child three and a half years old.

Hunter mentions Pepper's case of a female child who had at the age of three and a half weeks an enlarged abdomen which increased markedly until death at six and a half weeks. The liver and right suprarenal were infiltrated with a lymphosarcomatous tumor.

After a thorough search of the literature at that time, only five similar cases were found recorded—Heaton, Orr, Parker, de Ruyter, and Meisenbach. Stowell's case of hepatic fibrosarcoma occurred in an infant nine and a half months old. Spleen, lungs and heart were normal. Hunter mentions Homans' case of cæcal sarcoma in a girl aged five years, and quotes Stowell's statement in regards to his finding on record only ten cases of sarcoma of the liver in young children.

II.

Autopsy No. 45, 1900. University Hospital. Service of Dr. B. C. Hirst. Autopsy performed by Dr. S. Flexner. Mrs. Annie K. (vol. iii, p. 150, hospital). A well-developed woman. (Died April 28, 1900, 9 A.M.)

Anatomical Diagnosis.—Melanotic sarcomatosis; extensive tumor development in liver and gastrohepatic lymph-glands; growths in peritoneum, ovary, kidneys; hypostatic congestion of lungs; anæmia; splenic tumor.

Histological Diagnosis.—Melanotic alveolar sarcoma.

Liver: The right lobe of the liver extends almost to the iliac crest. Its total length is 36 cm. The left lobe is not enlarged, measures 14 cm. The diameter of the liver across the lobes is 26 cm. The elongation of the liver is brought about chiefly through the development of tumor masses in its substance. The largest of these occupies the tip of the right lobe of the liver, and measures 16 x 11 x 9 cm. Its anterior surface is closely adherent to the abdominal wall and to the omentum at the edges, and on separating the adhesions to the abdominal wall a thin, dark, luminous fluid escapes. The separated surface is excavated, and of a dark chocolate color and partially softened.

Extending along the right border of this lobe of the liver are numerous smaller metastases averaging an almond in size, although some are larger and others smaller. They project above the surface of the liver; the centres are dark in color and the peripheries pale and many of them give the impression of being cystic, others are firm. About the middle of the anterior surface of the liver similar nodules, but paler in color, can be made out. On palpation other and even larger nodules occur throughout this lobe of the liver. The posterior surface of the right lobe is occupied almost entirely by tumor masses. The largest is in the midportion extending over the transverse fissure, and measures 15 x 12 cm. in superficial area. Very little, if any, of the posterior surface of the right lobe is free from nodules. The left lobe presents on its posterior surface about one-half dozen small metastases, additional ones can be felt in the depth. On section of the right lobe posteriorly there is a continuous mass of tumor, 22 cm. long, occupying the lower portion of the right lobe. In the superior portion of the right lobe there is a circular mass, 8 cm. long, and smaller masses exist in between. The long mass situated in the inferior portion of the liver is a continuous tumor growth. No liver tissue can be made out until the very end is reached, where a very thin, cortical layer is demonstrable. There is, indeed, very little liver tissue left in the right lobe. The left lobe contains perfectly discrete tumor nodules, which project above the surface after section. The lobus Spigelii is free from metastasis, as is the lobus quadratus. The gastrohepatic lymph-glands form a tumor measuring 11 x 4 cm. in extent. It is extensively cystic, although some of the enlarged glands are still solid, yet very soft. The pigmentation is irregular, the tumor being for the most part degenerated, some of the areas being quite dark, others quite pale in color.

The liver weighs 4500 gms.

The cæcum is greatly depressed by the right lobe of the liver, and about this there is an open tumor, occurring chiefly in the mesentery, which is flat, of a pinkish-brown or chocolate color, and that seems to have developed on the surface of the tissue. This extends a distance of 10 cm. in somewhat irregular lines. Other parts on the peritoneum show small metastasis, these being chiefly on the abdominal wall and in the pelvis. The mesenteric glands are, however, free. The retro-peritoneal glands are enlarged and very dark in color. On incising

the right mamma a very extensively degenerated tumor is found to occupy the gland, substituting itself for the gland tissue and pushing itself into the fat. It is oval in shape, about 5 cm. in diameter, and is distinctly lobulated. To one side of this mass in the fat is a second nodule, the size of a marble, also pigmented.

Right kidney shows metastasis. In some of the appendices epiploicæ there are nodules of tumor. Spleen, uterus, heart, lungs, and pancreas are normal. Brain and eyes not examined. There is no tumor made out in the skin.

III.

SECONDARY SARCOMA OF LIVER

No. 3993. January 16, 1913. Blockley Hospital, September 9, 1912. Service of Doctor Loux. Thomas W., black, male, aged thirty-eight years. Admitted to the hospital March 22, 1912.

Autopsy (Univ. Penna.) Records.—No. 103, 1912, xxiv. Secondary sarcoma of the large spindle-cell variety of lung, left kidney, and liver. The gall-bladder, pancreas, intestines, stomach, adrenals and right kidney apparently normal. The liver weighs 1430 gms., 25 x 18 x 7 cm. Shows areas of tumor extending into the liver substance from 1 to 3 mm. in thickness. These nodules resemble those in the lung. In the spleen is apparently seen a fibrinous growth of endothelioid cells.

This is a case of large spindle-celled sarcoma of the tibia, with metastases to the liver, kidney and lungs.

Primary carcinoma and cirrhosis of the liver is rare. Sarcoma and cirrhosis of the liver is even rarer. Recently Dr. Alfred Stengel (1921) had a case of primary carcinoma of the liver in a young adult, male. Finley and Adami reported a case with this combination (*Montreal Medical Journal*, April, 1895). Fussell and Kelly (1895) reported two cases of a similar nature. Sotti, Thomson, Rispal, Thorel, Tollemer, Travis, and others have also reported cases of primary carcinoma of the liver with cirrhosis.

W. W. Ford (*Am. J. M. Scs.*, October, 1900, p. 413) reported a case of primary sarcoma of the liver with cirrhosis of the liver which occurred in the Montreal General Hospital. The patient was a man aged fifty-nine years. There was a combination of an extreme grade

of cirrhosis of the liver with a large sarcomatous mass in the right lobe, and a number of secondary nodules scattered throughout the peritoneal cavity. The mesentery and omentum were filled with small nodules the size of a pea. The stomach, intestines and rectum were normal. The tumor mass consisted of dense fibrous tissue infiltrated with sarcomatous cells, both spindle cells and small round cells. The liver corresponded in type to the ordinary atrophic cirrhosis of Laennec or the alcoholic cirrhosis. This was probably the first case reported in America of a combination of cirrhosis with primary sarcoma of the liver. Ford states primary sarcomas of the liver are exceedingly rare, and mentions as genuine cases those recorded by Horup, Arnold, Lancereaux, Waring, Windrath, von Kahlden and others.

Leopold Hudson's case (1888) was a woman fifty-three years of age. The liver weighed $225\frac{1}{2}$ ounces. The primary malignant mass was in the extreme left lower part of the right lobe. The examination proved it to be an instance of primary carcinoma of liver. There were secondary deposits in the lung, left kidney and omental glands.

J. L. Rothrock's (1889, *Trans. Path. Soc., Phila.*, vol. xv, p. 19) case was one of primary sarcoma of the liver. The patient was a man aged thirty-four years, a salesman by occupation. He was a patient at the Philadelphia Hospital. The liver weighed nine and a quarter pounds. Stomach and intestines were normal. There were at least eight masses surrounding the pancreas, under the liver. Careful examination of the brain, eyes, testicles, and other organs showed to gross appearance no lesions.

R. Simonini (*Riforma Medica*, May 10, 12, 1902) states that primary sarcomata of the liver are rare, and in the whole literature only fifty cases have been reported, of which sixteen were in children. Simonini reports a case in a child aged three years. Suffered for a long time from gastro-intestinal disturbances and had been losing flesh. The boy complained of pain in the abdomen. His abdomen was enlarged, particularly upper half, tender on palpation and a tumor felt occupying the whole right upper portion of the abdomen. The urine showed the presence of sugar, urobilin and indican. Ascites appeared and child died. At autopsy the tumor proved to be a primary sarcoma of liver. Tumor was studded with nodules. He says these

tumors may be mistaken for hepatoptosis, cancer, amyloid liver, syphilitic liver, echinococcus cysts, etc.

A. Stengel and J. M. Anders (1889) reported a case of a very large omental sarcoma with involvement of the liver and bowel. No mention is made of the stomach. The patient was a white man, C. B., æt, thirty-five years, a Swiss, and laborer by occupation. The spleen, lungs, kidneys, and heart were not involved in the tumor process. From the intestines Stengel obtained the beef work, or *tænia mediocanellata*. The tumor was a round-celled sarcoma. The large masses together weighed thirteen pounds.

CONCLUSIONS

1. In a thorough study of the literature of the world and the autopsy records of the University of Pennsylvania, of all recorded cases of primary sarcoma of the gastro-intestinal tract, liver, gall-bladder and pancreas, and in a study extending over a period of a year, and including private reports from hospitals, clinicians and surgeons in all the large medical centers of America, I have been able to collect about 592 cases.

2. The results of this study showed that there are 265 cases of primary sarcoma of the stomach, 65 in the tongue, 21 in the esophagus, 130 in the large and small intestines, 19 in the pancreas, only 17 in the appendix (including my own case, *Am. J. M. Scs.*, 1821), only 59 in the liver, and 16 in the gall-bladder.

3. Cases of primary sarcoma of the liver are very rare, and all discovered cases should be reported.

4. Cases of primary sarcoma of the alimentary canal, pancreas, and gall-bladder are also rare, and such cases should be carefully studied and reported.

5. A brief review of the literature on primary sarcoma of the liver is given.

6. A case of primary sarcoma of the liver, recorded in the autopsy records of the University of Pennsylvania, is herein reported.

I wish to express my thanks for the assistance given me by Professor Allen J. Smith, of the University of Pennsylvania, and for his permission to study and review the excellent autopsy records kept by him (1876-1920), and for the privilege to make the notes on the cases herein reported.

SARCOMA OF THE LIVER

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ATELEIOTIC DWARFISM

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ATELEIOSIS (the Greek word *ateleia* means incompleteness) was introduced by Hastings Gilford¹ as a convenient term for the conditions of dwarfism illustrated in this paper, on account of the incompleteness of development characteristic of all cases. The epiphysial cartilages in these cases may persist to an advanced age or throughout life. Gilford² quotes the account by Schaaffhausen of a male dwarf who died at the age of sixty-one years; at the post-mortem examination nearly all the epiphyses were still ununited or could be easily separated. The same characteristic feature was present in the skeleton of Paltauf's case, a male dwarf, when he died of tuberculosis at the age of forty-nine years.

I have recently had the opportunity of examining two male cases, one of whom (Case I) first came under my observation in April, 1910. A medical friend told me that the little man in question must be the true "Peter Pan" (of Barrie's famous play), because "he would never grow up." During the eleven years since 1910, ossification has, according to the results of Röntgen-ray examinations, only very slightly progressed in the hands. It is interesting in both cases to compare the retarded development of the intelligence (according to mental tests) with the retarded state of the physical development. Some of this group of cases seem to be connected in some way with pituitary gland deficiency, but in other cases the developmental arrest may be related chiefly to other endocrine glands. Unfortunately I neglected in my cases to especially study the effect of ateleiosis on the eruption of the permanent teeth, and I do not know that this question has attracted the attention of others or whether in this respect there is really anything abnormal to note.

CASE I.—The patient, who is now fifty-three years old, was shown by me at the Royal Society of Medicine, Section for the Study of Disease in Children, in May, 1910, when he was forty-two years of

¹ Hastings Gilford, *Medico-Chirurgical Transactions*, London, 1902, Vol. lxxv, p. 305.

² Hastings Gilford, *op. cit.*, p. 325.

age (*Proceedings*, 1910, vol. iii, p. 143), but I will first quote from my account when I described the case at the Clinical Section of the same Society in April, 1913 (*Proceedings*, 1913, vol. vi, p. 197):

The patient, F. B. H., of English parentage, is an infantile dwarf, aged just forty-five, whose height without boots or shoes is 120.5 cm. ($47\frac{1}{2}$ in.) and who at present weighs 26.5 kilogrammes ($58\frac{3}{10}$ English lbs.) without clothes. He has heard his parents say that he was much like other children up to the age of nine, but that his growth and development then ceased. He is said to have had "water on the brain" as a baby, and, as a child, to have had two or three falls on the head. He cannot himself remember having had any serious illness. There is no history of chronic diarrhœa or intestinal steatorrhœa. His head is rather large for the diminutive size of his body. The shape of his trunk, the undeveloped state of his sexual organs, the appearance of his neck (owing to the want of projection of the "pomum Adami"), and the high pitch of his voice, are those of a child, but his expression, the wrinkles on his face, his attitude, his manner of speaking, and his general behavior, are somewhat more those of an adult. His mental development is childish, but otherwise not abnormal. He cannot read or write, but, apparently "on account of weakness," the doctor would not let him go to school as a child. He earns a little money by light work in a glass factory. At the age of about nine years, when his growth ceased, he was already employed in a glass factory, and according to his account, when he came out of the hot work-rooms into the open air, he used often to have an attack of faintness and sometimes used to fall down. Dr. Reginald Langdon-Down has kindly examined the patient's mental development by the Binet tests (April, 1913), and he reports as follows:

"This patient is interesting, as he was deliberately deprived of school instruction on medical advice, and, on the other hand, owing to his mature years has long been subject to the influences of everyday life in town. The result of this environment has been to produce a superficial sharpness in one or two directions, which might readily mislead one in judging of his intellectual development. In grading him the modified scale of the Binet tests has been used, which avoids as far as possible tests which depend upon the results of instruction. The examination shows that he has reached an intellectual development such as is reached by the average child aged eight."

His father and mother were both born in 1832, and lived to about

the ages of fifty-six and fifty respectively. There is no history of any other dwarfism or infantilism in the family.

He has as yet no grey hair or baldness on his scalp. There is no hair on his face or pubes or in his axillæ. The penis is exceedingly small. No testicle can be felt on the right side; the left testicle of about the size of a small cherry, is incompletely descended. Nothing abnormal can be discovered in the heart, lungs, or blood-vessels, or in the abdomen (by palpation), or by examination of the urine. Pulse, 100 per minute. Brachial systolic blood-pressure, 145 mm. Hg. Blood examination (Doctor Bauch, April, 1913): Hæmoglobin, 80 per cent.; red cells, 5,040,000, and white cells, 15,900, to the cubic millimetre of blood. The abdomen is rather prominent, so as to form a kind of "Alderman's paunch," and the development of the subcutaneous fat about the back of the neck and the front of the thorax is of somewhat eunuchoid type. He apparently has never had penile erections or sexual desire, but has had nocturnal emissions occasionally. The texture of the skin, the facial complexion, the extreme fineness of the hairs of the scalp, and the small size of his thyroid gland, all suggest that there may be an element of hypothyroidism combined with the ateleiosis, but these features may be merely a part of the general infantilism.

Examination of the eyes (Dr. R. Gruber, April, 1913): The pupillary reactions are normal. In each eye there is a little horizontal nystagmus on exact fixation of objects. In each eye there is a central corneal macula (from old inflammation), with a little pigment on the anterior capsule of the lens. The optic discs are both normal. In the left eye one and a half disc-diameters above the optic disc is a well-defined circular area (resulting from old retino-choroiditis), a little larger than the optic disc, over which the retinal pigment has disappeared (with the exception of some small irregular specks), so that the choroidal vessels are clearly visible. At the inner upper peripheral portion of this area there is a small spot of shining silvery-white appearance, lying around a retinal artery, which it partly covers. The visual acuity for the right eye is $\frac{6}{36}$, and for the left eye about $\frac{6}{24}$. With the perimeter the fields of vision cannot be exactly traced out, but there is no temporal hemianopsia. There is no color blindness. The atrophic retino-choroidal patch in the left eye is similar in appearance to patches supposed to be seen after recovery from miliary tubercles of the choroid. The impairment of

vision and the nystagmus are probably due to the old corneal maculæ. Examination of the ears (Mr. G. J. Jenkins) shows nothing abnormal, excepting that the external auditory meatus is of the infantile type. It may be here mentioned that the patient's knee-jerks are very difficult to obtain, but are not altogether absent; there is no ankle clonus; the plantar reflexes are of the normal flexor type.

In regard to the condition of the skeleton, there is slight spinal scoliosis. Skiagrams (Dr. N. S. Finzi) of the extremities show persistence of some of the epiphysial cartilages, but the amount of union of the epiphyses with the diaphyses varies considerably in different bones. Doctor Finzi points out that in the skiagrams of the hands those epiphyses which are not yet joined to the diaphyses, and some of the diaphyses themselves, are seen to be bordered by a very deep shadow, as if they were bordered by sclerosed bone. The epiphysis of the terminal phalanx of each little finger is represented by a single very black line, as if it entirely consisted of very much sclerosed bone. In the same skiagrams the carpal bones seem to be relatively more developed than the bones of the metacarpus and fingers. Fresh skiagrams of the sella turcica region, recently taken by Doctor Finzi, seem to show that the posterior clinoid process is very thick, but slight variations in the position of the head may make considerable differences in the skiagraphic appearances at the base of the skull. The pituitary fossa, is, however, almost certainly rather small.

I last saw the little man in December, 1920. He then looked much the same as before, but his face was perhaps slightly more wrinkled and there was a suggestion of "gerodermia" of the face and hands. His general appearance is excellently shown by the photographs taken in December, 1920 (Figs. 1 and 2. F. B. H. is on the observer's right). Röntgen skiagrams of the hands taken in December, 1920, are likewise illustrated (Fig. 3). The epiphysial ossification in some of the phalanges (for instance, at the proximal ends of second phalanges of the second to fifth fingers) seems to have progressed a very little since 1913 (Fig. 4). A skiagram (December, 1920) of the pituitary fossa region of the base of the skull showed the same doubtful appearance which in 1913 was suggested to be due to the presence of a very thick posterior clinoid process.

CASE II.—J. B., said to be thirty-five years old, of Polish Hebrew parentage, came under my observation in December, 1920. He is an

FIG. 1.



Ateleiosis dwarfism.

FIG. 2.



Ateleiosis dwarfism.

FIG. 3.



Ateleiosis dwarfism.

FIG. 4.



Ateleiosis dwarfism.

infantile dwarf, 130 cm. in height ($51\frac{1}{5}$ in.) and 30 kilogrammes in weight (66 English lbs). His general appearance is well shown in the photographs reproduced here, which were taken in December, 1920 (Figs. 1 and 2. He is on the observer's left hand). In development of body he is not equal to a boy of ten years. His arms and legs are long in proportion to his trunk, and his head appears somewhat large. There is no facial, pubic or axillary hair. There is a good deal of subcutaneous fat on the trunk. The penis is very small and there is cryptorchism on both sides. The ateleiosis in this case is of what Hastings Gilford calls the "asexual variety," that is to say, associated with cryptorchism and absence of the secondary manifestations of sex (cf. Gilford, *Proceedings of the Royal Society of Medicine, Clinical Section*, 1911, vol. v, p. 35). The "pomum Adami" in the neck is very badly developed and I could not feel the thyroid gland distinctly. There is no evidence of disease of the thoracic or abdominal viscera. His urine is free from albumin and sugar. There is no diabetes insipidus. Brachial systolic blood-pressure (December 17, 1920): 115 mm. Hg. The Wassermann reaction is negative. There is considerable myopia in both eyes. The pupils react to light and accommodation. There is nothing abnormal in the fundi by ophthalmoscopic examination (Dr. C. Markus). Röntgen-ray examination of the thorax (Dr. James Metcalfe) shows delicate thin ribs like those of a child. At the base of the skull the pituitary fossa appears shallow, but rather long from before backwards. In skiagrams of the hands (Fig. 5) and feet the epiphysial union appears imperfect in some of the phalanges, etc. In the skiagrams of the hands some of the ununited epiphyses and some of the diaphyses are bordered by a very deep shadow (sclerosed bone).

The patient's twin sister (of course, not homologous twin) is rather small and says that she did not commence to menstruate till she was sixteen years of age. According to her account the patient, J. B., was normal up to the age of eight years and then ceased to grow or develop. He became depressed and conscious of his inferiority and did not care to associate with other boys. He is a tailor by trade, but has never been able to "earn his own living." He seems never to have had any serious illness, but is subject to headaches and "nervousness." There is no history of any other dwarfism or infantilism in the family. Their father lived to eighty-five and their mother to seventy-five years of age.

In regard to the patient's mental development, not only can he not earn his own living, but he is subject to childish attacks of temper, and if annoyed may lose all self-control. Dr. Reginald Langdon-Down (December, 1920) kindly examined his intelligence by the Stanford Revision of the Binet-Simon mental tests, and found it barely equal to that of a normal boy of nine years. The tests were difficult to apply owing to language difference, but every possible credit was given to the patient.

In conclusion I will refer to a *third case* of ateleiotic dwarfism, in which also Dr. R. Langdon-Down kindly examined the mental development for me. The patient (E. B.), a female, aged twenty and three quarters years, was shown by me at the Royal Society of Medicine, Clinical Section, on April 11, 1913 (*Proceedings*, 1913, vol. vi, p. 201). She had hardly increased in height or general development since the age of twelve years. In regard to the osseous system, there was slight spinal scoliosis. Skiagrams (Dr. N. S. Finzi) showed abnormal persistence of epiphysial cartilages. In those taken of the hands most of the epiphyses were seen to be bordered by a very deep shadow, as if by sclerosed bone. Skiagrams of the region of the sella turcica at the base of the skull seemed to show a rather small pituitary fossa. Doctor Langdon-Down's report on the patient's intelligence, as estimated by the Binet mental tests (April, 1913), was as follows: "This patient suffers from the drawback of a slight defect of hearing, which probably affected her response to some of the tests to a certain degree, for which allowance has been made. The examination shows that she has an intellectual development equivalent to that reached by the average child aged about thirteen or fourteen. It is admitted that the differentiation of natural capacity towards the upper limit of the scale is more difficult, even with the revised Binet's tests, or their modification by Goddard, and these are at present in a tentative stage and do not attempt a closer approximation over twelve than a test for age fifteen, and one for ages more than fifteen. This case seems to fall just short of the fifteen standard. It is obvious that social status and environment may exercise considerable influence in these higher levels, and that standardization becomes more difficult owing to increasing complexity of development and individual divergences."

FIG. 5.



Ateleiosis dwarfism.

A CLINICAL STUDY ON HYDATID PSEUDOTUBERCULOSIS OF THE PERITONEUM

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PATHOLOGY

TAKEN by itself, echinococcal pseudotuberculosis of the peritoneum does not give rise to any subjective or objective symptom. Excepting a few cases where the anamnesis caused the surgeon to suspect the real condition of affairs and therefore to look for it systematically at the time of the operation, the discovery of the peritoneal involvement has always been a matter of surprise, either because the interference was undertaken without a precise diagnosis having been made or because the operation was for a recognized hydatid cyst. When a hydatid pseudotuberculosis of the peritoneum has been discovered it has either misled the operator altogether or caused him to hesitate in his treatment.

For these reasons it is essential to know the objective characters of the process, as well as the conditions that give rise to it. As is readily understood, the knowledge of the macroscopic aspects of the lesion is of more importance to the surgeon than the histologic ones, but the data obtained by the microscope are nevertheless of great practical interest, as I shall show.

In considering the *macroscopic* lesions the following are essential: (1) The nature of the fluid collection often present in hydatid pseudotuberculosis; (2) the peritoneal reactions; (3) the objective characters of the granulations; (4) the frequent association of these lesions with those of secondary peritoneal echinococcosis, and (5) the condition of the primary cyst, the origin of the dissemination.

Of the twenty-six cases that I have been able to collect, a fluid collection is mentioned in eleven. In two of these cases (Cases X and XXV) it was an ordinary yellow ascitic collection, while in the others the collection was peculiar and described in 1902, by D  v  , by the name of *hydatid choleperitoneum*. The simple serous collection does not seem to have been directly provoked by the granulations playing the part of foreign bodies. In Case X the ascites resulted from

a mechanical pathogenesis, a parietal pylephlebitis of the portal vein causing compression of the hilum of the liver.

In eight cases (Cases II, IIb, IV, V, VII, VIII, XVII and XX) laparotomy gave exit to a cloudy bile-stained fluid that occasionally left a kind of muddy deposit on the viscera. In Case XXI the fluid was cloudy and gave a suspicion of suppuration and perhaps in reality was a choleperitoneum.

It is to be remarked that bile-stained intraperitoneal collections are found in other cases, but it had become spontaneously absorbed and at the time of operation only traces could be detected. Thus in Case XIII, the pseudotubercles offered a light yellow color that the microscope showed was due to collections of bile pigment. It was undoubtedly the same condition in Case XIX where operation revealed besides transparent cysts, other dark green and yellow cysts scattered among them. Choleperitoneum may even become spontaneously absorbed without leaving any trace, as is made evident in Case XX, because two years and a half after an exploratory laparotomy at which choleperitoneum had been found and whose origin had not been determined, a second interference gave issue to a light yellow ascitic fluid without any trace of bile, accompanied by multiple intra-abdominal cysts.

When there is no choleperitoneum, the lesions of the serosa consist especially in adhesions, either discrete or extensive, often finely vascularized and appear to less the result of persistent irritation of the peritoneum from foreign bodies than as a vestige of an inflammatory process dating from the rupture of the primary hydatid cyst. In fact, it is known that the rupture is followed by attenuated peritoneal manifestations, usually temporary in kind.

In case of cholerrhagic collections, the bile-stained peritoneum is rough and extremely thick. The reactional layer that it forms on contact with the bile and which covers all the viscera may be as thick as one centimetre and it is on its surface that the pseudotuberculous granulations are embedded.

The great similarity in the aspect of these granulations with those of tuberculosis was evident in a number of the cases, so much so that Arce declared that at first sight he mistook them for tubercles, while Abadie stated that they could only be compared with a tuberculous generalization over the peritoneum. If it had not been for two

small hydatid vesicles which Tusini found free in the peritoneal cavity, the macroscopic aspect of the process combined with its special clinical appearance would have led to the diagnosis of a tuberculous process. Villemin found the entire intestinal surface, the mesentery and all the peritoneal folds studded with thousands of small cysts simulating tuberculous granulations of peritoneal tuberculosis.

Hesitation has been great in some instances. Picquet and Claeys found a large number of tiny nodules the size of a millet seed scattered over the intestines, some being whitish and opaque, others gray in color and translucent. They recalled tuberculous granulations so closely that it might have been thought that the two processes were present on the peritoneum at the same time. De Quervain declares that the aspect of the process recalled tuberculosis of the peritoneum so greatly that for an instant he entertained doubts as to the correctness of the clinical diagnosis made before operation, while in one of my unpublished cases, that due to my brother, a mistake was almost made during operation and shows the exactitude of the name of pseudotuberculous peritonitis given to the process of Dévé.

Let us now examine more closely the characters of the granulations in question—their distribution, size, shape and color, likewise their consistency. Occasionally discrete and thinly scattered over the peritoneum, but more often numerous, sometimes even really confluent, the granulations are usually distributed over the entire surface of the serosa, the parietal as well as the visceral peritonem. But quite frequently the lesions seem to predominate on certain regions or organs, in the pelvis, mesentery or omentum, on the intestinal coils or in the hepatic region.

Their size varies from a pin's head to a grain of sago, or even less, to that of a hemp-seed or pea. Their average size is that of a millet-seed.

In shape they are sometimes round and pearly, at others oblong or flat like a lentil, or they may be irregular and knotty. Their color likewise varies. Some are translucent, opaline; others are gray, whitish, opaque and cloudy; others are yellowish, while some are distinctly caseous, containing a whitish or grayish-yellow magma.

Their consistency is usually elastic, but may be hard, because the smaller granulations may become incrustated with lime salts. Although possessing a tuberculous aspect, the characters of the granulations are

evidently somewhat variable. This polymorphism of the lesions in the same patient is to be especially noted. It is yet more marked in certain instances by the coexistence of multiple cystic tumors in the abdominal cavity, themselves in various stages of development.

As to multiple hydatid cysts of the peritoneum—a secondary peritoneal echinococcosis—it is needless to describe them in detail. Their localization of choice is in the omentum, pelvis, iliac fossæ, subdiaphragmatic, perihepatic and perisplenic areas. I would merely recall the fact that besides living, tense cysts, filled with clear fluid and hydatid sand, there are others that have collapsed and form small masses, containing withered gelatiniform membranes, often coated by a whitish-gray, caseous magma, more or less infiltrated with lime salts, to such an extent that they may form a solid chalky body. In this case one is dealing with a process of involution of the secondary echinococcosis that Dévé was the first to describe and which has remained classic.

Whether they be in activity or in involution, these secondary cysts of the peritoneal cavity are very frequently accompanied by pseudotuberculous nodules. In these circumstances, as Dévé has pointed out, the nature of the granulations is singularly enlightened by the presence of other specific lesions, all the more so because one usually finds all the intermediary states between the small miliary granulation of tuberculous aspect and the cyst filled with clear fluid or pathognomonic vesicular débris. But it must be made clear that besides these *mixed* cases, others are met with in which the pseudotuberculous granulations are in a pure state.

This latter condition is observed when the surgical interference is resorted to very shortly after rupture of the cyst into the peritoneal cavity has taken place, at a time when the secondary cysts have not had the time to develop, that is to say, within a few weeks or months after the advent of the rupture. The same condition of affairs has been observed after a relatively long lapse of time as in Case XIII, in which the operation was done two years after a traumatic rupture of an hydatid cyst of the liver.

The last question to be referred to in reference to the macroscopic pathology of the process under consideration is the state of the primary cyst, the one responsible for the dissemination of the hydatid elements in the peritoneal cavity.

Theoretically, the primary cyst is susceptible of being seated in any one the abdominal viscera. But since echinococcus is far more prone to develop in the liver than elsewhere, in practice one is fairly certain to find it in the hepatic gland. In fact, when the cases I have been able to collect for this paper are carefully read, it will be found that in all of them, where the seat of the primary cyst is mentioned, it was seated in the liver. Nevertheless, it can be conceived that a cyst of the spleen might eventually become the starting-point of the peritoneal process and an unpublished case due to Doctor Sabadini that I shall report from another point of view, confirms this hypothesis.

An interesting peculiarity upon which Dévé particularly insists is that, as a rule, every hydatid cyst that has been emptied—be it by puncture or rupture—becomes a complicated cyst. As far as cysts of the liver are concerned, three changes may be observed in the ruptured pocket. (1) The transformation of a simple cyst—univesicular—into a complex cyst with a multivesicular content. (2) The invasion of the collapsed cyst by bile—secondary intracystic cholerrhagia. (3) Spontaneous suppuration of the pocket, invariably of biliary origin.

The condition of the primary cyst is mentioned in eleven of our collected cases. Twice suppuration had taken place, seven times it was invaded by bile, and in only two, after a lapse of two months only, did the cyst have a limpid contents.

Microscopic Lesions.—In studying the granulations found on the peritoneum of the pelvis in a patient who three months previously had undergone puncture of a cyst of the liver, Graham noted for the first time that these granulations of tuberculous aspect were composed by numerous young connective-tissue cells surrounding young hydatid formations. He was able to detect booklets in some. After Graham, Krückmann and Lehne pointed out the presence of giant-cells in contact with parasitic formations in general, while in 1897, de Quervain published the first detailed histological description of the lesion under consideration.

De Quervain's examinations were carried out on a bit of omentum removed at operation (see Case IV). This specimen contained a nodule one to two millimetres in diameter along with a certain number of much smaller tubercles. The fundamental tissue was composed

of connective tissue very rich in cells and very vascular in some areas. It was evidently not normal omental tissue but a cellular neoformation. Fatty tissue was only observed at one spot. The smaller nodules were composed of some giant-cells—sometimes only two—around which the connective tissue rich in cells was concentrically deposited. In the larger nodules epithelioid cells were found between the giant-cells, especially at the periphery. Some of the small tubercles contained hydatid débris, but nowhere were booklets or evidences of a scolex to be found.

Riemann has also given an account of microscopic findings in two cases (Cases V and VII). Generally speaking, three zones could be made out in each tubercle, namely, (1) a central zone formed by a finely granular mass which stained poorly, in the midst of which cuticular débris could be made out, as well as a few hooklets; (2) a middle zone composed of fibrous tissue, and (3) a peripheral zone composed of a mass of round and fusiform cells closely piled together.

In a case of pseudotuberculous peritonitis, Tusini (Case VIII) found the following structure: A small mass composed by an accumulation of leucocytes infiltrated in the meshes of a very delicate connective tissue surrounding a bit of hydatid membrane. No giant-cell could be seen.

I now come to the fundamental work of Dévé, in which all the details of the histological lesions of hydatid peritoneal pseudotuberculosis are given in full. This study was based upon a series of data obtained from human pathology, veterinary pathology and lastly from experimental pathology. Doctor Dévé has been good enough to give me an outline of his work, so that I shall give it in his own words:

“The lesions are present in three distinctly different types, the first of which is the *tubercle of foreign bodies*. In the centre is to be found the débris of the leafy hydatid membrane *with or without* hooklets, bile pigment, cholesterin or lime salts. This central nucleus is surrounded by a circle of epithelioid cells mingled with giant-cells. Around these there is a more or less fibrous connective-tissue zone which isolates the foreign body represented by the hydatid tissues.

“The second type is the *fibroid organization of the scolex*. The characteristic elements—hooklets and lime-salt plates—of the scolex, either isolated or embedded in a fibrino-leucocytic mass, disappear, and there only remains a small connective-tissue nodule having no particular characteristics.

“The third type is the *active echinococcal vesicle*. The pseudotuberculous granulation is here formed by a small hydatid vesicle in full activity, surrounded by an atmosphere of young connective tissue. A zone of epithelioid and giant-cells can be seen in contact with its cuticle. The peripheral connective-tissue zone soon becomes organized into lamellæ of fibrous tissue and then one has under the eye a *miniature hydatid cyst* capable of following its evolution to a more or less complete degree.”

In reality, the second type described by Duvé, has only been observed in experimental pathology and therefore is negligible for all practical purposes and it can be included in the first type described by him. Definitely, there remain two types—two hydatid pseudotuberculoses—that it is essential to separate from each other. In one, the pseudotuberculous granulation, it has *inactive* débris in the centre, the outcome of parasitic formations arrested in their evolution. This is the *cured pseudotuberculosis*.

In the other, the nodule is formed by a *vivacious* secondary hydatid vesicle in the early phase of its development. This is the *premonitory pseudotuberculosis of secondary echinococcosis*.

These two elementary lesions, whose signification is so different, have the same objective aspect, and upon this point I desire to insist, namely, that *it is impossible to distinguish one from the other by the naked eye*, especially by a rapid and superficial examination such as is made by the surgeon during a laparotomy. A histological examination of a bit of morbid tissue removed by the surgeon at operation is the only means of deciding upon the exact nature of the lesion, as well as ascertaining the degree of vitality of the pathological process. It is readily conceived how great the interest will be from the viewpoint of the ulterior prognosis of the affection from the data derived from microscopic examination. I shall, for that matter, refer to this subject further on in this paper.

ETIOLOGY AND PATHOGENESIS

The cause of pseudotuberculous secondary hydatid peritonitis is the intraperitoneal rupture of a fertile hydatid cyst—whether or not this cyst be primary, as is usually the case, or is a secondary process. In the latter case it might, as Duvé and Railliet have pointed out, be properly called *tertiary echinococcosis*.

The original cyst is usually in the liver and the rupture is very frequently spontaneous, as seems to be the fact in nineteen of the cases here recorded. The rupture is due to one of the many little strains occurring in daily life, but it has been known to take place while the patient was in repose. It may, *a fortiori*, be the result of a trauma, such as a fall as occurred in Case XIII.

In opposition to these spontaneous ruptures are to be placed those cases where the hydatid dissemination was produced artificially by a medical or surgical interference. In two instances (Cases I and XXIII) the inoculation of the peritoneum was produced by exploratory puncture of the primary cyst and this could also result in surgical operations for removal of the cyst if the peritoneal cavity is insufficiently protected.

The age and sex of the patients have nothing to do as factors in the frequency of the morbid process. However, it is to be remarked that, from the viewpoint of age, hydatid pseudotuberculosis of the peritoneum is not exceptional after the age of forty years, an age when true tuberculous peritonitis becomes rather rare. This fact should be taken into consideration when making a differential diagnosis. If we take those cases utilizable from this standpoint we find that the affection occurred:

Between 10 to 20 years	5 cases
Between 20 to 30 years	4 cases
Between 30 to 40 years	2 cases
Between 40 to 50 years	6 cases
Between 50 to 60 years	3 cases

The question now arises as to how long after rupture of the primary cyst does the dissemination within the peritoneal cavity take place? From this viewpoint the cases are to be divided into two groups. At times the lesions have been met with from within a few weeks to two to four months after rupture (Cases I, II, IV, V, XV, XXIII and XXV)—and then the lesions were usually *pure*; at others, it was only after the lapse of several years following the initial inoculation that the cases came under observation (Cases VI, VII, X, XI, XIII, XVI, XIX, XX, XXI)—and in these circumstances there was almost always an association of the pseudotuberculous lesions with multiple cysts of the peritoneum.

Looked at in a general way, hydatid pseudotuberculosis of the

peritoneum represents a reaction of defense of the organism against the inert echinococcal elements—débris of membranes—or living elements, scolex, proligerous capsules, small hydatids—disseminated throughout the peritoneal cavity.

At this point it is proper to recall that the lesion in question is not special to man, as it is also observed in veterinary pathology. Pécard has reported a case of peritoneal echinococcosis in a dog and he remarks that "between the many cysts, on their surface and in the folds of the peritoneum, were an enormous number of very small ones, the size of a pin's head to that of a pea or filbert. In some areas the parietal and diaphragmatic peritoneum were covered by translucent or whitish miliary granulations, recalling the lesions of tuberculous peritonitis. These morbid products, on account of their special aspect, certainly merit the name hydatid pseudotuberculosis given by Dévé to similar lesions found in man."

I will give notes of a case in a monkey that I studied with Professor Dévé. The animal had experimental primary hydatid cysts of the liver, while in various areas of the omentum were seen small whitish granulations which accompanied a series of peritoneal cysts some of which were opaque and collapsed, the others tense and transparent. These peritoneal cysts were due to spontaneous rupture of the hepatic cysts which had thrown the contents either intact or ruptured into the abdominal serosa. The histological examination of the omental granulations showed that they were typical hydatid pseudotubercles with epithelioid and giant-cells and in their centre there were small bits of lamellar cuticular membrane.

And what is more, this lesion was reproduced experimentally by covering a dog's peritoneum with hydatid sand and cuticular débris. A positive result was likewise obtained in a rabbit and guinea-pig. Thus the experimental method allowed one to observe and study the reactions of the organisms in respect to parasitic foreign bodies.

According to Dévé two principal processes characterize the first phases of this defense: (1) An inclusion of the foreign body in a fibrinous exudate, and (2) an afflux of migratory cells.

Macroscopically, the fibrinous reaction is made evident by the appearance of ramified whitish spots, forming a kind of floating mesh-work which imprisons the echinococcal elements that are free in the serous cavity. It may end by the formation of adhesions or by a

true false membrane. As to the migratory cells—without speaking of their antitoxic action which is still somewhat hypothetical—they play, in respect to certain elements, a mechanical part whose demonstration is easy to make. All that is necessary is to inject hydatid sand into the peritoneal cavity of a guinea-pig and at the end of twenty-four hours to remove a few drops of peritoneal serum. Dévé has thus been able to find leucocytes that had phagocyted the hooklets.

One other point still remains for discussion. It concerns the pathogenic relations that may exist between the presence of choleperitoneum and echinococcal pseudotuberculosis. In order to fix the frequency of this coincidence, it should first be recalled that in eight of the twenty-six cases collected in this paper the granulations were accompanied by an abundant bilious collection and that in two others undoubted traces of a former choleperitoneum having undergone spontaneous absorption were found. It is quite possible that the same coincidence had occurred in other cases, because by Case XX we know that all evidence of a bilious collection may disappear within a few years after absorption of a choleperitoneum of seven months' duration.

Now, it is very certain that the bile attacks the vitality of the hydatid germs when it is in intimate and prolonged contact with them, so that it seems quite plausible to admit that its parasitocidal action may have played an active part in the development of the cured pseudotuberculosis often observed in such circumstances.

Nevertheless—and this is a new point to which Dévé has called attention and to which he has given an experimental demonstration—the hydatid elements are not as sensitive to the action of the bile as has been admitted for a long time. The germs disseminated at the time of rupture of the cyst may become grafted upon the serous membrane and *there develop regardless of the presence of bile*. Beaudet, in his thesis (Paris, 1906) on "Hydatid Choleperitoneum," was able to collect eleven instances of this type. The case later published by Morestin (Case XX) is most suggestive in this respect.

It is true that perhaps the germs which continued to undergo their evolution in this case were protected from direct contact with the bile at an early date by a partial adhesion between the peritoneal folds, by adhesions and a reactional fibrinous exudate which embedded them and played the part of an isolating barrier. It may also be that the intraperitoneal cholerrhagia did not follow immediately upon the

rupture of the cyst, and that consequently the echinococcal elements had time to become encysted before eruption of the bile took place.

Whatever may be the reason for this peculiarity, what is certain is that *a collection of bile associated with an hydatid pseudotuberculosis does not constitute a guarantee against the evolution of the inoculated hydatid germs*, nor does it prevent the ulterior development secondary cysts in the abdomen or pelvis. This notion should be kept in mind when the prognosis of the affection is considered.

SYMPTOMATOLOGY

What has already been said in the foregoing pages on the pathology and pathogenesis of the affection under consideration explains why this morbid process does not usually give vent to any clinical sign. In reality, the small nodules grafted on the peritoneum do not react upon any of the subjacent viscera—liver and spleen—and, on the other hand, the reactional process remaining closely circumscribed and local is not accompanied by any irritation of the serosa—exception being made of the early phase of rupture and for an ulterior ascitic collection whose pathogenesis may be a complex one.

De Quervain already observed: "This form of tuberculosis of foreign bodies does not give rise to any subjective symptomatology and cannot be detected by objective exploration." And Dévé says: "In itself, hydatid pseudotuberculosis has no clinical expression." It is a silent and latent lesion."

It is consequently yet more curious to note that, in a certain number of instances, the clinicians had suspected in the circumstances, a tuberculous peritonitis. Now, what was there in the symptomatology that caused the suspicion of peritoneal tuberculosis? Let us take the cases one by one and by so doing this review will give at the same time an idea of the clinical aspect of the facts in question.

Tusini's patient was a woman of some fifty years who was taken with epigastric pain followed by vomiting, eight months before she came under observation; then fever appeared, accompanied by nocturnal sweating. The abdomen became slowly and progressively distended. Examination revealed a well-developed abdomen, a collateral venous circulation and a projecting umbilicus. Exploration of the groins revealed enlarged lymphnodes. By palpation and percussion

of the abdomen all the signs of a mobile ascitic collection could be made out and a diagnosis of probable tuberculous peritonitis was made. Operation gave issue to a cloudy yellowish liquid containing fibrinous shreds. It was a case of hydatid choleperitoneum.

In Dévé's case the patient was a male forty-four years old, with an ascites accompanied by œdema of the lower limbs. The affection, whose onset was obscure, appeared to date back several years. After withdrawing the fluid by paracentesis, numerous masses could be detected within the abdomen. These were multiple cysts of the omentum. As to the ascites, it was due to a chronic pylephlebitis the result of compression by a large hepatic cyst.

Morestin's patient was a young woman, twenty-seven years old. The abdomen was very large, uniformly distended by a peritoneal collection offering all the signs of an abundant ascites. The general health was mediocre, the patient had lost weight for several months, complained of frequent diarrhœa and paroxysms of pain which appeared to be related to the bad condition of the intestine. Exploration was negative in respect to the liver, spleen and uterine adnexa. Finding no other explanation for the ascites, it was thought to be due to peritoneal tuberculosis. As there was no doughiness and no lumps, and as the ascites was considerable and free within the abdomen, the case was regarded as favorable for operation. This was done and an hydatid choleperitoneum found.

In Weber's case, the patient was a female forty-three years of age, presenting a bosselated, movable tumor in the right half of the abdomen. Small bosselated tumors were detected in Douglas' pouch to the right of the uterus. A diagnosis of tuberculous peritonitis, probably having the right ovary and tube as starting-point, was made. The abdominal tumor was supposed to be formed by "an omentum infiltrated with tuberculous granulations." Operation revealed multiple cysts in the abdominal cavity.

Cochez's patient was a lad sixteen years of age. The limbs were extremely thin, the abdomen enormous. Numerous enlarged lymph-nodes were present in the axillary and inguinal regions. The distended abdomen was smooth and presented a collateral circulation which spread over the lower border of the thorax. Percussion dulness was general excepting over the stomach. No abdominal fluctuation could be made out. Palpation revealed numerous nodules which

formed a cake-like mass, similar to that found in tuberculous peritonitis. The past and present history of the patient led to the diagnosis of this affection. At operation multiple cysts of the abdomen were found.

In all these cases the primary cyst in the liver was overlooked, while the tuberculous aspect of the cases was the result of either choleperitoneum or multiple peritoneal cysts. It was entirely to this coexistence that the hydatid pseudotuberculosis assumed the clinical aspect of peritoneal tuberculosis. The clinical mistake—which is most excusable in the circumstances—is prone to lead the surgeon to make a similar mistake when the lesions are exposed to view at operation.

DIAGNOSIS

Now, since peritoneal hydatid pseudotuberculosis is deprived of any distinctive diagnostic sign, how can this lesion be suspected? There is one special circumstance which may lead the clinician to suspect it with considerable probability, *viz.*, when a patient with an evident cyst of the liver gives a history of a fairly recent intraperitoneal rupture of this cyst, namely, sudden pain, collapse of the hepatic tumor, phenomena of collapse, vomiting, peritonism and urticaria, with or without a rise of temperature.

This is precisely what occurred in Bataille and Dévé's case (Case XIII). A patient with an unquestioned diagnosis of multiple hydatid cysts of the liver was admitted to hospital for operation. In going over his antecedents very distinct signs of traumatic rupture of one of the cysts were obtained. The patient had fallen on the abdomen and this was immediately followed by pain, collapse and symptoms of peritonitis. This accident occurred two years previously. Examination revealed nothing abnormal in the abdomen—no collection, tumors or induration, and at operation the hepatic and infrahepatic peritoneum was found normal. However, while exploring the omentum for traces of the former rupture a number of small, yellowish-white nodules were discovered which microscopically proved to be echinococcal pseudotubercles.

But intraperitoneal rupture is far from always giving rise to the complete characteristic symptomatology and there are cases of what may be called "concealed types" of intraperitoneal rupture of the cyst and in these circumstances the results of the accident remain

latent. Therefore, it is evident that there is always need of *systematically exploring the omentum in every operation undertaken for hydatid cyst of the liver.*

Even when the primary visceral hydatid cyst has been overlooked in the diagnosis there are two circumstances in which a sagacious operator will recognize the lesions at operation. The first is when tuberculous granulations coexist with one or more hydatid cysts of the omentum or pelvis; the second when a torpid bilious collection is discovered which has occurred spontaneously and whose walls are studded with "tuberculous" nodules.

Now with such lesions exposed to view there are errors of interpretation that must be avoided. A diagnosis of white areas due to steatonecrosis of pancreatic origin is hardly possible to make, because the areas in question are flat and subendothelial in location and are accompanied by a serohemorrhagic peritoneal collection, while the clinical history is, in the circumstances, very different from that obtained in hydatid pseudotuberculosis.

The differential diagnosis with cancerous peritonitis may be a more delicate matter. However, here, too, the clinical history is different and the eruption of cancerous granulations is usually accompanied by a more or less hemorrhagic ascites. Then besides, exploration of the abdomen reveals recognized neoplasm.

Tuberculous peritonitis is unquestionably the principal cause of mistakes and confusion is all the more easy because the clinical diagnosis is often that of tuberculosis. The similarity in the aspect of the lesions to which I have already referred, has caused hesitation in the mind of the operator.

In at least one case the diagnostic error has been committed. This was Case II, in which a peritoneal bilious collection existed, but this should not occur if the characters of hydatid choleperitoneum be recalled.

The operator's attention should naturally be awakened in respect to the probable echinococcal nature of the peritoneal granulations when these coexist with an hydatid cyst of the liver or spleen, whether a history of rupture has been or not obtained in the patient's antecedents. But as I have already pointed out, the primary cyst has not always been detected clinically and the surgeon operates for a supposed tuberculous peritonitis, and then finding "tuberculous"

granulations on the peritoneum and viscera the diagnosis is supposed to be correct, and even if he should think of looking for an hydatid cyst of the liver or spleen, it will often be a matter of difficulty to recognize it and this for several reasons.

In the first place, the operator will usually have made an incision *below* the umbilicus, and if this is not prolonged upward to the epigastrium the cysts will escape notice. Secondly, adhesions are frequently present in the infrahepatic region which present or hinder proper exploration, and lastly, because the ruptured primary cyst will have collapsed more or less completely.

The problem becomes still more complicated from the fact *that a coincidence is possible and that a tuberculous peritonitis may coexist with an hydatid cyst of the liver*. In fact, it is known that it is not exceptional for a tuberculosis to become grafted in cases of hydatid cysts and to develop later on those who have previously been operated on for this pathological process, although the cases so far reported were instances of pulmonary tuberculosis, but there is no reason why a peritoneal localization should not likewise occur.

The coexistence of a tuberculous peritonitis with an hydatid cyst of the liver has been mentioned in some of the published cases. I would at once remark that some of these case-reports are wanting in precision and, therefore, are far from convincing, as for example, Cramer's case.

A female was admitted to hospital on July 17, 1895. Ten months previously she was seized with pain in the abdomen and at the time noticed a tumor in the epigastrium. In April, 1895, suddenly fainted and suffered a marked collapse. Following this accident the *abdominal swelling disappeared*. The patient remained in bed for several days with pain in the lower abdomen. Some weeks later the tumor reappeared and increased in size.

No tuberculosis in hereditary antecedents.

Operation July 18. Incision over the tumor. A yellowish fluid escaped from the peritoneal cavity. The stomach and an intestinal loop were seen to be covered with small white granulations the size of a pin's head. Farther on, a pocket with lax walls which had pushed down the stomach and liver was discovered and this was thought to be a pocket of encysted tuberculous peritonitis, and was incised. This gave issue to a cloudy yellow liquid containing scoleces. Marsup-

ialization. Recovery uneventful, in spite of an abundant cholerrhagia.

The patient was discharged cured. Seen on May 12, 1896, she presented no evidence of a return of the affection.

Regardless of the title: "*Tuberculosis peritonei mit Echinococcus hepatis subphrenicus*," given by Cramer to the case, it is in no way demonstrative. He gives no proof of the bacillary nature of the lesions; there was no tuberculosis in the patient's antecedents and nothing was found clinically in the lungs. The patient recovered rapidly and remained cured. All these are reasons for doubting the really tuberculous nature of the granulations and when it is noted that an undoubted rupture of an unquestioned hepatic cyst into the peritoneum had previously taken place, and when it is evident that the operator was in the presence of a choleperitoneum—and this can hardly be questioned—it is only possible to believe that Cramer was in reality dealing with an echinococcal pseudotuberculosis of the peritoneum accompanied by hydatid choleperitoneum.

I therefore feel that this case may be safely included with the others I have collected, and the only reason it was discussed here was merely to show that the title under which it was published was a misnomer and also to show how easily a mistaken diagnosis of such cases can be made in practice. It is possible that this case can be placed in the same category as the one referred to by Quénu at the Surgical Society of Paris (January 10, 1900), who stated that in one of his operations he found an hydatid cyst of the liver with an eruption of tuberculous granulations over the peritoneum. However, the possible coexistence of an authentic tuberculous peritonitis with a cyst of the liver cannot be doubted.*

It has been met with by Lagos-Garcia in a case of operation for an hydatid cyst of the liver in which the peritoneum was studded with small miliary granulations which led him to suspect that he was dealing with the pseudotuberculous form of secondary echinococcosis. However, microscopic sections showed that the granulations were unquestionably tuberculous.

I here report an unpublished case due to Dr. P. Carnot, to whom my thanks are due for permission to include it in this paper.

A male, aet. forty-eight years, was admitted to hospital on Jan-

* See on this subject: Cæsar. *Über Riesenzellenbildung bei Echinococcus*, etc. Inaug. Diss. Tübingen. 1901. Zschentzsch, Inaug. Diss. Zurich, 1910. Case III.

uary 19, 1911, for abdominal pain in the supra-umbilical region. It was present in both hypochondriums—especially the left—and in both flanks. This pain, which frequently extended to the right leg, gave rise to sharp diurnal exacerbations, occasionally also nocturnal. It occurred even when the patient was resting and was not notably exaggerated by work. It, however, increased when the patient bent forward, but the ingestion of food did not cause it to occur. There was nausea and obstinate constipation.

The patient was very emaciated. The abdomen tense, projecting and globular. No collateral circulation. An extensive mass with indistinct contour could be palpated in the right hypochondrium and flank. Another mass with indefinite outline could be felt in the left flank and iliac fossa.

There was nothing abnormal in the lungs. Auscultations of the heart revealed an extra-cardiac murmur, systolic in time, and a click of the second aortic sound. No albumin, no syphilis, apyrexia.

The most probable clinical diagnosis appeared to be chronic tuberculous peritonitis. However, the mass felt in the right hypochondrium led to the suspicion of an hydatid cyst and Doctor Weinberg was requested to make a blood examination.

Doctor Weinberg reported on January 31 as follows: *Wassermann negative; reaction of hydatid fixation distinctly positive.* The hæmoleucocytic formula was: polynuclears, 77 per cent.; mononuclears, 17 per cent.; lymphocytes, 5.66 per cent., and eosinophiles, 0.33 per cent.

A diagnosis of hydatid cyst of the liver was consequently made, perhaps complicated by secondary abdominal cysts or tuberculous peritonitis. The patient was transferred to the surgical service of Doctor Souligout.

OPERATION

Median incision below the umbilicus. A mass of intestine was adherent to the anterior parietal peritoneum which was greatly thickened. Multiple fibrous bands prevented exploration, but granulations of an unquestionable tuberculous nature were seen and a bit of tissue was excised for microscopic examination.

In face of the difficulty of getting into the peritoneal cavity and for fear of injuring the intestine, nothing further was done and the abdominal incision was closed without drainage. Recovery was sim-

ple and apyretic. The incision healed by first intention in its upper two-thirds, but there was a little suppuration in the lower third.

Histologic examination of the bit of tissue excised at operation showed *typical tuberculous lesions*: caseous nodules with a zone of round cells, without giant cells, lodged in a mass of inflammatory connective tissue.

March 10: Soft white œdema of legs. No albumin in urine. No collateral circulation, but there was some slight pain in the right popliteal region. Dechloridation diet.

March 20: Œdema persisted, less on left, increased on right. Abdominal incision still incompletely closed.

March 27: Œdema almost completely disappeared. Abdominal incision red and tender.

March 29: Patient coughed a good deal in the night. Abdominal dressings pus-soaked, with some fecal matter as well. A fecal fistula had formed.

April 3: The liquid from the fistula was green, bilious in nature and hardly smelled of fœces. Carmin given by mouth stained the discharge in six hours.

June 12: Death from cachexia.

AUTOPSY

The abdominal contents had to be removed *en masse*, because all the viscera were matted together by adhesions. Three vertical incisions had to be made vertical and parallel to each other in the middle line and to the right of each hypochondrium, interesting the entire visceral mass. By these incisions two hydatid pockets of long standing were discovered deeply seated within the liver. One was in the right lobe and was the size of a lemon, irregular in shape, containing collapsed gelatinous membranes without either fluid or living hydatids. It was an old cyst undergoing involution. The second cyst was lodged in the left lobe and was the size of an orange, irregular in shape and contained numerous hydatids, some living, others collapsed. No other cysts could be found.

As to the peritoneal fibroid mass it was studded with more or less caseous tubercles.

Histological examination of the liver, spleen and omentum revealed the presence of characteristic tuberculous lesions. The liver presented fatty degeneration—the fatty tuberculous liver.

This case seems to be interesting from several points of view. In the first place, from the clinical standpoint it shows the error in diagnosis due to the fibrous tuberculous peritonitis which simulated a tumor of the liver—an hydatid cyst. I purposely say simulated because in the circumstances the two intrahepatic cysts, deeply hidden in the hypochondriums, were impossible to detect clinically.

The case is no less suggestive from the viewpoint of the value of the reaction of the fixation of the complement. Here was a patient in which Weinberg's reaction, made by Weinberg himself, was frankly positive and the laboratory diagnosis was hydatid cyst. Now, at operation, an undoubted tuberculous peritonitis was discovered and confirmed by microscopic examination. The laboratory diagnosis was again correct because six months later at autopsy two hydatid cysts were found in the liver but which could not be discovered for obvious reasons at the operation.*

Finally, looked at from our particular standpoint, this case is interesting in proving the reality of a possible association of peritoneal tuberculosis and hepatic echinococcosis.

From this discussion the point to be recalled is the difficulty sometimes encountered in determining the exact nature of the lesion by mere macroscopical examination and the necessity of invariably resorting to a histopathologic examination of a bit of excised tissue removed at operation. *This is the only means of certitude in diagnosis.* It is not only useful for the diagnosis, but at the same time indicates the prognosis of the lesion to a certain extent.

PROGNOSIS

In concluding his paper in 1897, de Quervain says: "So far as one may judge at the present time, peritonitis from echinococcal foreign bodies (*Echinokokkenfreundkorper peritonitis*) is the most favorable outcome of rupture of the cysts. *It is without importance for the patient, at least in mild cases.*"

This conclusion, even attenuated by the reserve contained in the

* It should be remarked that cases have been reported in which Weinberg's reaction done by competent men has given *positive results in cases where no hydatid cysts existed.* Such a case has been reported by Tuffier and quite recently Dévé saw a patient with a voluminous abdominal tumor in which a distinctly positive Weinberg reaction was obtained. A careful autopsy revealed a very large hetero-hepatic hypernephroma, but no trace of hydatid cyst could be discovered.

latter part of the phrase, appears to me far too optimistic. In principle, the prognosis of hydatid pseudotuberculosis of the peritoneum will differ greatly according to whether one is dealing with one or the other type of lesion that I have described. Essentially benign in *retrogressive, residual cicatricial pseudotuberculosis*, it is very bad in *active, progressive premonitory secondary echinococcosis*. Microscopic examination of the lesions will give precious data from this viewpoint.

But the fact must not be lost sight of that *in practice both types of lesion very often coexist*. Side by side, or at some distance from the permanently extinguished granulations, others are to be found in full activity so that microscopic examination of the bit of tissue excised at operation cannot offer an absolute guarantee as to the future, even when it shows several healed granulations.

A *clinical examination*, periodically and thoroughly carried out in all patients who have been operated on, is absolutely necessary, as it is the only means we have of detecting an ulterior explosion of secondary cysts in certain regions of election. In this respect there is one examination the importance of which Dévé has particularly insisted. I refer to rectal and vaginal examination which will reveal at an early date the development of these parasites in Douglas' pouch which is the declivous point of the abdominopelvic cavity. A careful palpation of the iliac fossæ, inguinal regions and the flanks, likewise of the cicatrix of the abdominal incision, will also give important data by showing the presence of small, rounded, resistant and mobile tumors.

Radioscopic examination can only give vague data and these only at an advanced stage of the process.

On the other hand, we have in the reaction of fixation of the complement a most sensitive diagnostic measure, susceptible of giving very precise data. Nevertheless, it must be admitted that a complete accord among biologists as to *the signification of a positive reaction persisting after excision of the cyst or cysts* does not as yet exist.

According to Weinberg, who of course is an authority on the subject, "the specific antibodies disappear slowly from the blood-serum of patients operated for hydatid cysts." He has found a positive reaction six, nine, fifteen and twenty-two months, two years, five years and six years and three months afterward and he admits that the interpretation should be reserved in those cases where the reaction is still manifest after several years.

According to Apphatie and Lorenz—biologists having a vast experience in the matter of echinococcoses—the problem is still unsolved. They have seen the reaction disappear within six months after operation in one case and in another persist up to the eleventh month.

On the other hand, Parvu, who has studied this subject for several years, makes formal reserve in instances of prolonged positive reactions. Lejars and Parvu maintain that in these circumstances a plurality of the cysts is to be suspected or else a recurrence has taken place.

Quite recently Laubry and Parvu came to the conclusion that “the antibodies disappear from the blood within a lapse of time varying from three weeks to six months after removal of the cyst” and that “the persistency of the antibodies beyond much over six months indicates that a cyst has been overlooked at operation or else there is a recurrence.”

The question has reached this point at present and from my standpoint its importance can readily be conceived. If Laubry and Parvu's opinion should be correct, the persistency of the reaction for over six months after a complete removal of the primary cyst would assume a high prognostic value, because it would signify either that other primary cysts exist that were overlooked at operation or that the pseudotubercles seen at the operation were of the active type and should lead one to fear the explosion of a secondary echinococcosis still in a latent state—unless, as Dévé pointed out to me, it is not shown later on that the persistency in the tissues of hydatid *débris*, even when deprived of vitality, are sufficient to keep up the specific reaction for several years.

An undoubted rupture of an hydatid cyst into the peritoneum consequently should always offer a reserved prognosis. However, it should be recalled that “every intraperitoneal rupture of a cyst, *even when fertile*, is not fatally followed by an eclosion of a secondary echinococcosis” (Dévé).

I am indebted to Doctor Sabadini, surgeon to the hospitals of Algiers, for the following unpublished case, which is most suggestive, although in it no mention is made of hydatid pseudotuberculosis, but it is so closely related to the subject under discussion that it is worth reporting.

Female, aet. eighteen years, entered hospital March 18, 1905.

Face pale, pulse frequent but strong, abdomen distended. Temperature, 37.6° C. (99.6° F.). Patient very restless and replies to questions with difficulty. All that can be learned is that the abdomen has increased in size during the past few months, especially in the left upper quadrant and that she has suffered fearfully for the past three days.

On examination the abdomen was found very tense and particularly so over the left hypochondrium. Palpation revealed an enormous tumor occupying the entire left side of the abdomen, from the false ribs to the pelvis, and extending over the midline to the right to the extent of one to two fingers' breadth. It was resistant and dull over its entire extent to within two to three fingers' breadth of the femoral arch. Below this line of dulness a sonorous zone could be distinctly made out. By palpation one had a sensation of an enormous tumor filled with fluid in maximum tension.

The patient was a virgin, therefore a rectal examination was made. The pelvis was empty and the exploring finger could detect no tumor. There was, therefore, no connection between the organs of generation and the abdominal tumor. This fact was important because at first sight a torsion of an ovarian cyst was suspected.

The data obtained by combined abdomino-rectal examination consequently showed that the tumor was essentially abdominal with a subcostal development, as the tumor could be felt extending under the costal border. When the two sides were compared, the left false ribs were distinctly seen to bulge outwardly, forming a marked swelling.

The diagnosis then made was an hydatid cyst of the spleen in maximum tension, therefore to be operated on without delay. This was done the following day, but when seen early in the morning Sabadini was at once struck by the patient's face which was reddened and covered with patches of urticaria. Rupture of the cyst was at once suspected.

The patient then told how she had suffered the day before and a part of the night, but at about two o'clock in the morning she experienced a kind of cracking in the left side, after which a sensation of heat extended throughout the abdomen, and from this time on all discomfort and suffering disappeared and she thought herself quite well again.

The entire body was covered with patches of urticaria just as the face was. The abdomen was flattened and soft, pulse rapid, apyrexia and the general condition satisfactory.

Laparotomy was done in the afternoon. An incision commencing six centimetres above the umbilicus was carried down to the middle of the umbilico-pubic line, and when the peritoneum was opened the cavity was found to contain quite a good amount of yellowish fluid. The patient was turned on the side to allow the fluid to flow off, after which a search was made for the cyst. A resistant mass was first found and proved to be the left kidney in ectopia. To reach the cyst, which could be felt through the greater omentum, the latter was split with the finger and the cystic pocket was exposed. It was whitish in color and the size of a large foetal head. It arose from the internal aspect of the spleen, but was deeply lodged under the false ribs. Therefore a lateral counter-opening was made, parallel with the false ribs, ten centimetres (four inches) long.

The sac was seized by clamps, the peritoneal cavity was emptied completely of the remaining cystic fluid, and the abdominal incision closed by through-and-through sutures of silver wire. Next the cyst was brought with some difficulty through the second incision and incised to the extent of some six or seven centimetres (about three inches), keeping it outside the incision. The germinal membrane was extracted and the cyst was emptied. It did not contain any daughter vesicles. The liquid in the cyst was quite large in amount and was a cloudy yellow. The interior of the cyst was dried and swabbed with a two per cent. formol solution. Lastly, the sac was marsupialized on the incision with silver wire sutures and two large drains introduced.

During the operation the pulse was very rapid and small, so that physiologic salt solution and fifty centigrams of caffein were given.

The dressings were removed on the third day and it was found that the silver wire had caused necrobiosis of the borders of the sac. The latter was excised little by little at each change of dressing.

The patient regained strength, and by May 23 the cystic cavity had disappeared. The patient was discharged on July 30.

Seen on December 9, 1905, was found well. The incision parallel to false ribs, to which cyst had been sutured, was found retracted under the costal border. There was a tiny fistula some nine centi-

metres (about four inches) deep which gave issue to a minute quantity of discharge. Exploration of the abdomen revealed nothing abnormal.

The patient was again seen in January, 1906, and after a minute examination was found to be free from any secondary echinococcosis. A year later there was no recurrence of the process in the peritoneal cavity. Seen again in 1911, the patient was found to be in perfect health.

Here is a case which, six years after an averred intraperitoneal rupture of an hydatid cyst, remained free from secondary echinococcosis, but it must not be supposed that this process may not yet arise. Case XIII shows that the formation of secondary cysts may not become clinically apparent until nine years after the rupture of the primary cyst, so that a very long observation of these cases is essential before one may conclude that they are permanently cured.

TREATMENT

From the viewpoint of treatment only *active* hydatid pseudo-tubercles need be considered, because involutional pseudo-tubercles are extinct lesions and will give rise to no future trouble. Therefore, we need only consider the problem of treatment of *secondary echinococcosis in the very early phases of its development*.

Theoretically, this morbid process would seem *a priori* susceptible—and only susceptible—to attack lesions which, in a way, are embryonal and disseminated over the peritoneum, even into the most inaccessible regions of the abdominal cavity. No attention need be paid to small hydatid cadavers which remain after a cure of the primary lesion because they can never give rise to secondary infection. These small foreign bodies are lodged in the subperitoneal cellular tissue and consequently are walled in.

As Dévé has recently remarked, a specific internal treatment is especially desirable for dealing with an echinococcal inoculation resulting from spontaneous, traumatic or operative rupture of a fertile cyst, as it would realize an ideal prophylaxis of secondary echinococcosis and in the past some endeavors have been made in this direction.

The older physicians, as we know, endeavored to reach the parasites lodged in the viscera—liver, lung, brain, etc.—by the internal exhibition of certain drugs. Potassium iodide and mercury were

utilized and proved, but in reality not a single convincing proof was ever brought forward to back up this therapeutic action. Murchison, Frerichs, Semmola, and Thomassi have shown, for that matter, that potassium iodide, even when taken in large doses for a number of days preceding puncture of, or operation on, the cyst, was never detected in the fluid of the cyst.

With the same hope and for some time Irish and Australian physicians employed tincture of kamala, whose anthelmintic virtues were proven by veterinary surgeons, but the results were *nil*. More recently, de Renzi, following the practice of Filetti and Piazza-Martini endeavored to revive this method of treatment by prescribing the ethereal extract of male fern at the daily dose of one and a half to two grammes. They maintain that by the use of this drug they have obtained a rapid cure of a cyst of the liver and another of the lung. The first case is said to have been cured in twenty days, the second—whose cyst ruptured into the bronchi—was cured after “a few” days of treatment.

This question of treatment advocated by de Renzi was of such interest that Dévé decided to test it experimentally and therefore he tested the action of the extract of male fern on the development of hydatid grafts.

The outcome of these experiments, in which equal or even greater doses were given than those advised by de Renzi in man and during a much longer time, was that male fern is *without any action* on the evolution of echinococcal cysts produced in the rabbit inoculation of hydatid sand (scolex). It would consequently seem that this treatment should be discarded as useless.

A few years ago another treatment was proposed which, applied to the cases dealt with in this paper, might be of great value. I refer to radiotherapy. Diaz de la Quintana published, in 1904, the case of a female who he stated he had cured of multiple large cysts of the liver after forty-seven applications of the X-rays.

This single observation made a great cry in the medical press at the time and again Dévé submitted the question to experimental verification. He attempted to discover what might be the action of the X-rays on hydatid sand (scolex) when inoculated subcutaneously in the rabbit. In the experiments carried out the results were absolutely *nil*; the grafts developed beautifully without being influenced whatever by the X-rays.

A few words may now be said regarding the essays made by Dévé for obtaining an antiechinococcal serum. Taking as a basis some data obtained in human and veterinary pathology and the experimental verification of the natural resistance offered by certain animals—guinea-pig and dog—to inoculation of hydatid sand, Dévé wondered if it would not be possible to obtain a serum which, injected in rabbits, might not render this animal refractory to inoculations of the scolex, by hyperimmunizing guinea-pigs and dogs. His experimental attempts have either been doubtful or failed completely. However, it does not seem irrational to hope that in the near future an antibody may be elaborated in the animal organism capable of arresting the development of the specific germs inoculated.

While awaiting the hypothetical realization of this specific treatment, the only resource for dealing with peritoneal hydatid granulations is surgery. Some surgeons have attempted to excise the lesions (Cases XI, XIII, XVI). But as can readily be conceived, they were compelled to give up trying to remove all the granulations. A prophylactic removal of the omentum covered with hydatid tubercles may evidently be done, but, in reality, the excision of this organ—which might cause disturbances later on—would simply remove the less dangerous lesions, because the really important ones to be destroyed are the perihepatic, intestinal and, above all, the pelvic granulations.

Friction made with a sterile gauze compress soaked in a physiological salt solution might, perhaps, be the best way of proceeding in the circumstances, but it must be done with discretion. At all events, irrigation of the peritoneal cavity with antiseptic solutions must be proscribed as it is quite as dangerous as it is illusory. The most that should be done would be to carefully swab the areas over which the granulations are the thickest with a one per cent. solution of formol as I. Le Noriène did (Case XXV). Nevertheless it may be questioned whether the fixative action of the formol on the peritoneal tissue may not be more marked than its parasitocidal action in respect to the encysted germs—in other words, whether the disadvantages of this procedure do not outweigh the advantages.

Except in cases of notably developed vesicles—the size of a pea, for example—which undoubtedly might merely be crushed, it is safer to abstain from all attempts to destroy the lesions in this phase of the process. And this is the more rational because a certain num-

ber of granulations are destined to undergo a spontaneous involution, even after they have commenced to develop. Later on, when symptoms of a more or less diffuse echinococcosis in the peritoneum appear, it will be time to operate.

Space does not permit me to enter into a detailed study of the treatment of this dire affection. I would merely say that multiple cysts of the peritoneum should be treated piecemeal; that is to say, by a series of successive operations, and speaking broadly, the pelvic cystic masses should first be dealt with, no matter how apparent the other abdominal cysts may be. The reason for this statement resides in the serious compression resulting from cysts wedged in the osseous cavity of the pelvis and is all the more important because the process silently progresses and therefore should be dealt with before it has wrought too much damage.

PROPHYLAXIS

From what has been said of treatment it is evident that it is both incomplete and illusory, so that everything must be done to prevent a reformation of the process from taking place.

The prophylaxis of inoculating hydatids over the serosa of the abdomen must include that of spontaneous rupture of the primary cysts and their medical or surgical treatment, in both of which the cyst is opened.

To pretend to prevent either spontaneous or traumatic rupture of these cysts would be vain, because these accidents often occur before a diagnosis of the cyst has been made, even before the presence of an hepatic tumor has been suspected. Therefore, it can be said in no paradoxical way, that many subjects in apparent perfect health go about with an hydatid cyst of the liver on the point of rupture into the abdomen. Consequently, when a diagnosis of an intra-abdominal hydatid cyst has been made an operation is urgently required.

At the present time it is hardly necessary to refer to the importance of abstaining from making an exploratory puncture when an hydatid cyst is suspected, all the more so because by the reaction of the deviation of the complement we have what may be called a *specific* diagnostic sign.

As to artificial dissemination of the hydatid elements over the peritoneum during surgical interference for hydatid cysts it will be

avoided if the operator limits the operation to two steps whose importance is universally admitted, viz.: (1) An exact protection of the peritoneal cavity with gauze towels closely packed around the cyst before opening it, and (2) a parasiticide injection given before the operation as recommended by Dévé, destined to kill all the echinococcal germs contained in the cysts before the latter are incised and emptied of their contents.

I here give twenty-seven case reports of the pathologic process under consideration. Undoubtedly other authentic cases have been reported but if so, they have escaped my notice. Cases XXV and XXVI are due respectively to my brother Doctor Le Nouëne and Doctor Sabadini, of Algiers; they are reported for the first time, and I take this opportunity to thank them for allowing me the use of their clinical notes.

CASE I (Graham).—Female, with an hydatid cyst seated on the under surface of the liver. Died from cachexia three months later with a suppurative hepatic cyst. At autopsy the greater omentum was found studded with very small spots similar to white pearly tubercles; some of these were as large as a small pea. These granulations were also found on the upper surface of the spleen, kidneys and mesentery, but the area where these lesions offered the most remarkable aspect was the pelvic peritoneum in Douglas' pouch and utero-vesical recesses. Here the surface of the serosa felt rough and papillomatous. Some small granulations were found on the peritoneum of the bladder and both surfaces of the uterus. The majority of these granulations were hardly the size of sago.

Histological examinations of the omentum and a bit of the peritoneum from the pouch of Douglas revealed the characteristic structure of young hydatid formations. Stratification of the cuticle was noted, while numerous young connective tissue cells were proliferating actively in the ectocyst; some contained numerous small hooklets.

CASE II (Debove and Soupault).—Girl, æt. seventeen years, was seized suddenly on June 8, with a very severe pain in the right hypochondrium, accompanied by syncope and followed by dysuria and tenesmus. There was no history of either physical effort or a fall. During the next few days the pain decreased, but on the fifth day the abdomen commenced to distend slowly and progressively. On June 22 punctures of the abdomen gave issue to fluid so darkly colored that

it was thought that a greatly distended gall-bladder had been tapped.

Laparotomy was done on August 1. No distended gall-bladder was found, but a large number of white spots were seen on the peritoneum which were regarded as tubercles and the abdomen was closed.

Shortly after the laparotomy the ascites recurred, requiring two more paracenteses. The fluid withdrawn at the last puncture was examined microscopically and was found to consist of bilious fluid containing hooklets and débris of hydatid membrane.

The patient was discharged apparently cured in February, but she reëntered hospital a year later, at which time irregular-shaped masses could be made out in the abdomen, with symptoms of an infectious process of hepatic origin. Another operation was attempted, the patient dying the same night.

Autopsy revealed multiple cysts in the abdominal and pelvic cavities and a suppurating hydatid cyst of the liver.

CASE IIb (Cramer's case already detailed in the section on diagnosis).

CASE III (Lubarsh-Lehne).—At the autopsy of an individual in whom a rupture of an hydatid cyst of the liver had taken place, the surface of the liver and peritoneum was found covered with numerous tubercles which had developed around hydatid membranes.

CASE IV (De Quervain).—Girl, æt. nineteen years, noticed in August, 1896, some abdominal distention which she had never remarked previously. One day she made a considerable physical effort and immediately after experienced a very sharp abdominal pain followed soon after by an eruption of urticaria over the entire body. There were no other symptoms in the patient's antecedents.

However, the abdomen continued to enlarge and the patient entered hospital two weeks after the attack of urticaria. A diagnosis of hydatid cyst of the liver was made on account of the urticaria. Patient was kept under observation for two weeks when an exploratory paracentesis was done which led to the suspicion that the cyst had ruptured. On the next day a complete change had taken place as the cyst had ruptured again in the night, this time without giving rise to urticaria.

Laparotomy.—The omentum and intestine were everywhere adherent. The toughest adhesions were found a little to the right of the gall-bladder; here the omentum and gut were glued to the under surface of the liver. In breaking down the adhesions several litres of

bilious fluid escaped. The visceral peritoneum, mesentery and omentum were covered by a quantity of minute nodules varying in size from a millet seed to a hemp seed, the smaller ones being gray and transparent while the larger ones were opaque and whitish. The general aspect of the lesions so closely recalled tuberculosis of the peritoneum that at first there was doubt as to the accuracy of the diagnosis of hydatids.

However, the cloudy greenish nature of the intra-abdominal fluid collection was hardly compatible with the hypothesis of tuberculosis and continuing the exploration a cystic pocket containing greenish fluid, similar to that in the abdomen, was found on the under surface of the liver, but it was impossible to discover any perforation in this cyst, therefore it was incised.

Histological examination of the nodules revealed a pseudo-tuberculosis.

The postoperative results were simple. Two months after the operation the patient was in excellent condition and only had a small biliary fistula giving issue to very little secretion. Abdominal examination was negative and there was no trace of any intra-abdominal fluid collection.

CASE V (Riemann).—Male, æt. forty-seven years, entered hospital on March 23. Since last Christmas he had noticed that the abdomen was increasing in size. Two exploratory punctures performed during the previous weeks had given issue to a dark yellow fluid.

On examination several abdominal swellings were found. An exploratory puncture gave exit to a dark yellow fluid which was aspirated with difficulty. It offered no characteristic sign and contained no hooklets.

On April 4, the abdomen was opened, the omentum being somewhat adherent. Over its surface there were numerous nodules varying in size from a pin's head to a millet seed. Here and there were some slightly larger ones, some round, others oval or elongated in shape, yellowish in color and rather hard to the feel. The omentum was very vascular, somewhat puckered, but without inflammatory changes.

Behind and to the left of the omentum there was a large fluctuating mass which, when incised, gave issue to a large amount of cloudy yellow fluid containing daughter vesicles and membranes. This

pocket extended downward to the left into the pelvis which it filled. The inner surface was studded with daughter cysts, while its external surface offered isolated nodules the size of a millet seed.

Death on the following day. Autopsy revealed a cyst of the liver filled with a greenish fluid containing more or less collapsed hydatids stained with bile and communicating with the intra-abdominal collection. On the surface and in the omentum disseminated nodules were found recalling scoleces. These were also found on the peritoneum of the liver and intestine. Histological diagnosis: foreign body pseudotuberculosis.

CASE VI (Riemann).—Male, æt. fifty years, fell ill two years before coming under observation, with severe pain in the right hypochondrium and diarrhœa. At this time a physician noticed a swelling in the liver which later on retrogressed. The patient had five similar attacks during the past two years. About six months after the last attack a swelling appeared in the left flank and slowly increased in size.

On examination several round, movable, fluctuating tumors were discovered in the abdomen, as well as a tumor occupying the pelvis; the latter extended about three fingers' breadth above the symphysis pubis.

A supraumbilical midian laparotomy was done and adhesions uniting the pelvic tumor to the bladder were discovered. The incision was then extended above the umbilicus where the abdominal cavity was found to be free. Decortication of several peritoneal cysts which ruptured during manipulation. Very numerous small vesicles were discovered in the omentum as well as some very tiny gray nodules, the majority being the size of a pin's head or even smaller. A cyst occupying the left iliac fossa was opened.

Patient recovered without any complications. Some weeks later a pelvic cyst was puncture *per rectum* and flushed out with a carbolic and sublimate solution. One month later no trace of this cyst could be detected in the pouch of Douglas.

CASE VII (Riemann).—Female, æt. forty-six years, entered hospital for a strangulated umbilical hernia. Operation was done at once. Resection of a gangrenous coil of intestine. The peritoneum was granular and rough to the feel. The intestinal peritoneum was found to be covered in certain areas with fine whitish nodules. Sev-

eral litres of yellowish bilious fluid was removed from the abdomen.

A portion of the under surface of the liver was occupied by a cystic tumor the size of a child's head, which was relaxed like a rubber ball that had been pricked. In the retracted omentum on the mesocolon and in the folds of the intestine, which were fixed by adhesions, small cystic tumors were found varying in size from a pea to a filbert. Some of them were as transparent as crystal, while others possessed a hard whitish capsule and were opaque.

A cyst the size of a plum was peeled out of firm adhesions from the under surface of the liver and contained about a dozen daughter vesicles and numerous membranes.

The result of the findings at operation led to the conclusion that a dissemination of the hydatids had taken place from rupture of the primary hydatid cyst of the liver and upon questioning the patient it was ascertained that two years previously while carrying a pail of water she had felt a tearing sensation in the thorax. Following this accident the abdomen increased in size, and during the space of about ten months six abdominal paracenteses had to be done, from four to fifteen litres of a reddish liquid being withdrawn each time, the patient experiencing relief after each paracentesis. The umbilical eventration for which the patient entered hospital was the result of the great abdominal distention by the fluid.

CASE VIII (Tusini).—Female, æt. fifty-one years, entered hospital May 10, 1897. Onset of symptoms in September, 1896, epigastric pain, vomiting and fever with nocturnal sweat. In October the abdomen commenced to slowly but progressively increase in size.

Examination showed a large abdomen, a collateral venous circulation, projecting umbilicus and enlarged inguinal lymphnodes. A peritoneal fluid collection was made out, movable with the position of the patient. Fluctuation distinct. Liver and spleen appeared to be normal. Diagnosis: probably tuberculous peritonitis.

Operation.—After giving exit to a large amount of very cloudy yellowish fluid containing grayish-white fibrinous shreds, giving the fluid the aspect of that encountered in certain forms of tuberculous peritonitis, with an abundant fibrino-caseous deposit, débris of glazed membrane were removed from the depths of the pelvis and also two small opaque, gelatinous empty hydatid vesicles. When the peritoneal cavity had been freed of its pathologic contents, it was found that the

peritoneum was lined with a kind of membrane which enveloped all the abdominal viscera. This membrane was composed of lardaceous tissue containing a large number of small, grayish-yellow friable nodules appearing to be composed by a caseous substance which histologically proved to be hydatid pseudotubercles.

Above, the pocket continued with the liver, a portion of its lower posterior surface forming the vault of this sac.

After completely cleaning out the sac and in order to remove all the adherent gray mass an attempt was made at two points to remove this neoformed membrane, but the adhesions of the intestinal mass were such that it was deemed more prudent to desist from further manipulation and the abdominal cavity was packed with gauze and drained.

There was an abundant secretion by the drains and some elevation of the temperature, but soon amelioration was rapid and the patient was discharged on June 11, 1897.

Three years later the patient was able to lead the hard life of the peasant in the fields, so that a permanent cure was considered to have been attained.

Remark.—Tusini insists on the unusual aspect offered by the lesions. "In this case," he says, "if the two little hydatid vesicles found free in the peritoneal sac had not been discovered, simple macroscopic inspection of the lesions, combined with the special clinical aspect, would have easily led one to suppose that the process was tuberculous since there was absence of any visible trace of macroscopic parasitic elements."

CASE IX (Peyrot-Milian).—Male, æt. fifty-five years, presented multiple tumors of the abdomen.

At operation, a large median tumor was revealed over which the omentum was spread. It was a unilocular cyst which was removed after its fluid contents had been aspirated. A second cyst the size of a closed fist was next removed. This cyst was in the omentum to the right of the first cyst, and it was itself surrounded by small cysts varying in size from a filbert to a walnut. In proximity to these cysts the peritoneum was studded with whitish grains about the size of barley.

After this a retroperitoneal cyst was discovered, and then a flat-

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tened empty cyst of the liver. Finally, a juxta-splenic and a juxta-colic cyst were removed.

A bit of omentum excised during the operation contained some small cysts the size of a pea. Some of them were vesicular; others were soft, withered, and contained daughter vesicles. They were embedded in a grayish mass composed of a gelatiniform substance in which the microscope revealed crystals of cholesterin. Certain small cysts were yellow, hard and cretaceous. Finally, there were granulations on the omentum analogous to very fine miliary granulations.

CASE X (Dévé).—Male, æt. forty-four years, entered hospital for an ascites, accompanied by œdema of the lower limbs. The onset of the affection dated back eight years. Following paracentesis of the abdomen which gave exit to twelve litres of yellow fluid, the abdomen was explored. An enlarged liver with an irregular surface was made out, and a mammillate tumor was discovered in the right iliac fossa. Another large tumor occupied the entire hyogastrium. Several diagnoses were thought of, namely, fibro-caseous tuberculous peritonitis, cancer of the peritoneum, retro-peritoneal sarcoma, multiple fibromata and multiple hydatid cysts.

The patient died soon after, and at autopsy innumerable small transparent cysts were found on the surface of all the abdominal viscera. The liver contained three very large primary hydatid cysts.

The omentum was literally riddled with cysts about the size of cherries. Among these cysts were some living ones filled with transparent fluid. Several of the cysts were hardly the size of a cherry-stone or a smaller pea. The others were opaque, undergoing involution and were filled with a caseous substance containing crystals of cholesterin. The latter were about the size of a string bean, but others there were not larger than a small lentil. Finally, there were some very small ones only to be seen with a lens and were present in the form of fine whitish granulations.

CASE XI (Reboul).—Female, æt. eighteen years. When ten years old she experienced sharp abdominal pain and at the time a physician found a tumor. A month later she was well again. At the age of sixteen years the patient had another attack of abdominal pain which lasted a few days. The following year the patient married and became pregnant; this was followed by a normal labor. But the abdomen remained enlarged after the birth of the child and an examination revealed a pelvic tumor.

At operation multiple pelvic hydatid cysts were found and the peritoneum of the pelvis was covered with small miliary cysts. Some bits of peritoneum were excised and the peritoneum was brought together with catgut sutures where these excisions were made. As all these hydatid products could not be removed without removal of the entire pelvic peritoneum the cysts were swabbed with camphorated naphthol, because no formol was at hand.

The excised cysts were in full evolution, the cyst of the broad ligament, as well as the small miliary peritoneal cysts, as was made evident by microscopic examination.

CASE XII (Arce).—Arce states that he once met with a case of a multitude of small hydatid tumors scattered over both layers of the mesentery and which looked, at first sight, like a peritoneal tuberculosis or a secondary carcinomatosis.

CASE XIII (Bataille-Dévé).—Female, æt. twenty-four years, entered hospital November 5, 1904, for multiple cysts of the liver. In the antecedents an important accident was found to have taken place two years previously, on December 5, 1902. Following a fall on the abdomen, striking on a bottle, the patient was seized with very serious abdominal symptoms, accompanied by an eruption of "pimples," which was supposed to be due to fright. After this, the abdomen began to swell and remained enlarged and tender for more than two months.

The exact nature of the peritoneal accidents was not recognized at the time—a commencement of peritonitis had been suggested—but retrospectively they led to the conclusion that traumatic rupture of hepatic cysts into the peritoneal cavity had occurred. Therefore, at operation, which was done on November 15, 1904, by Doctor Bataille, the abdominal cavity was intentionally explored from this viewpoint.

When the abdomen was opened some yellow ascites was found with a slight degree of perihepatitis. The omentum was studded with irregular knotty nodules, varying in size from a millet seed to a lentil and yellowish-white in color. Histologic examination showed that the lesions were those of hydatid pseudotuberculosis.

Two hepatic cysts were incised, one of them being packed with daughter vesicles and contained bile. Each cyst was marsupialized separately and drained.

The patient's health steadily improved after the operation, but it

was evident that two cysts still remained in the right lobe of the liver, and these were operated on February 15, 1905.

The patient was seen in June, 1906, in excellent health. The abdomen was soft and no tumor could be detected by palpation of the hypochondriums, hypogastrium or iliac fossæ. There were no vesical or uterine symptoms.

Doctor Dévé has been good enough to give me the following notes of the ultimate outcome of the case: He saw the patient on December 10, 1911, seven years after the second operation and nine years after the initial rupture of the hepatic cyst. The patient at this time presented two resistant tumors—one in the epigastrium and one in the left hypochondrium—probably hydatid cysts whose site seemed to be perihepatic and perigastric, and probably secondary in nature. A very close examination of the abdomen, iliac fossæ and pelvis did not reveal any other tumor in the abdomino-pelvic cavity.

Since the last operation, the patient had married (June, 1906), and in May, 1907, she had had a perfectly normal labor.

Third operation (Doctor Bataille) on February 8, 1912. A median epigastric incision was made and exposed a cyst the size of a fist covered by adhesions. The cyst was incised and the membranes removed. Fixation of the cyst to the posterior abdominal wall. Abdominal incision closed without drainage.

A second incision was next made parallel with the left false ribs and a peritoneal cyst was exposed in front of the stomach, covered with loose adhesions, so that it could be completely removed. During extraction a small tear occurred in the cyst with exit of hydatid fluid outside the abdomen, although perhaps a few drops may have fallen into the cavity. Abdominal incision closed without drainage, after making sure that no other cysts existed within the abdomen. The post-operative period was remarkably simple and the patient was discharged on the ninth day in excellent condition.

CASE XIV (Riemann-Becker).—Male, æt. forty-two years, had typhoid one year before coming under observation, at which time several abdominal tumors were found. Six months ago, serious abdominal symptoms arose and a tumor in the pouch of Douglas and above the bladder was detected. On the third day of the illness hydatid débris were voided in the urine and the vesical tumor then decreased in size. After this, there was an amelioration.

Examination revealed a normal liver. On the right of the umbilicus a very movable tumor the size of a fist could be made out and another smaller one was found in the lower left side of the abdomen. A third tumor existed above the pubic symphysis on the top of the bladder.

At operation two hydatid cysts of the mesentery were enucleated, and another in the mesocolon. After this the cyst in the pelvis, located on the posterior aspect of the bladder, was removed. In the right lobe of the liver was an hydatid cyst the size of a fist. The intestinal peritoneum was covered with innumerable small yellowish nodules which were also echinococcal in nature.

The patient was discharged one month after the operation and was still alive five years later, although he had a return of the hydatids.

CASE XV (Lagos and Garcia).—A little girl with an hydatid cyst of the liver presented evident symptoms of rupture of the cyst, occurring sometime before coming under observation. Attention having been given to this point, the abdomen was carefully explored at operation and the omentum, mesentery and peritoneum, both visceral and parietal, was found studded with small granulations, whose aspect, size and distribution resembled lesions of tuberculous peritonitis. Microscopically the nodules contained the débris of scolex and chitinous lamellæ, thus demonstrating the echinococcal nature of these morbid products.

CASE XVI (Paschkis).—Male, æt. fifty-five years, had always been well until four years before coming under observation, at which time he had abdominal inflammation, with fever, and was in bed for four days. No other data could be obtained. Patient complained of vesical and rectal disturbances. A retrovesical cystic tumor was detected.

An extraperitoneal suprapubic incision was made and the tumor exposed. It was aspirated and 500 c.c. clear fluid was withdrawn. The opening made by the needle was closed with a hæmostat and an attempt was made to enucleate the cyst outside of the peritoneal cavity. When the apex of the tumor was reached the peritoneum was torn and then it was found that both on the parietal and intestinal peritoneum were a number of small yellowish-white tuberculous tumors, varying in size from a pea to a filbert. Some were distinctly pedunculated, cystic in nature and possessed a yellowish-white resistant wall.

Besides these tumors, there were innumerable small miliary nodules hardly as large as a pin's head. The patient recovered.

A bit of tissue was excised for microscopical examination, but the writers do not give the result of this examination.

CASE XVII (Tarozzi).—Female, æt. thirty-seven years, entered hospital a few days before she died, for a severe ascites which, according to the patient had existed for over four years. The patient's condition was such that nothing was done, not even paracentesis.

Autopsy.—Great emaciation, œdema of lower limbs, a non-icteric earthy color of the integument. Abdomen enormously distended.

Incision of the abdomen gave issue to fifteen litres of yellowish-green fluid, which was at first clear and afterwards became cloudy. In the very cloudy fluid which was in the declivous parts small bits of hydatid membrane were floating. The intestinal mass was retracted on the spine and slightly displaced to the left. Both parietal and visceral peritoneum were thick, rough to the feel, bright red in color and especially intense in the pelvis. This peculiar color was found to exist on the upper aspect of the liver, lower surface of the diaphragm and the peritoneum covering the intestine and mesentery.

Closer inspection of the peritoneal surface, especially that of the pelvis, revealed very small dots, hardly as large as a pin's head, although very visible and over which the red color became a little paler. Exploring the retro-uterine cul-de-sac, an oval body free in the pouch was discovered, with a finely granular surface. It was friable and composed of hard particles giving the sensation of fine sand. The body was also bright red in color.

Five or six centimetres below the tip of the sternum was a cystic cavity the size of a foetal head containing numerous daughter vesicles for the most part intact, and filled with hydatid fluid. They were contained in a very thick-walled mother cyst and stained yellowish-green by blood suffusion. Many of the ruptured hydatids were also impregnated with the same green color. The mother cyst offered at its antero-inferior aspect a large tear which allowed the cavity to communicate with the abdominal cavity by the intermediary of a kind of irregular sinus running through a mass of cicatricial adhesions.

On the under surface of the liver there were two swellings, one the size of a walnut, the other of a mandarin orange plunged in the hepatic parenchyma, but manifestly capsular in origin. There was

yet a third one the size of a pea. All three were quite independent of each other. In exploring the fatty tissue of the great omentum a small nodule was discovered which on section proved to be a small cyst containing clear fluid.

Histologic examination of the small peritoneal granulations especially abundant in the pelvis, showed that they were small miliary cysts which had died and had provoked a peculiar reaction around them, "representing the lesion to which the name of hydatid pseudotuberculosis has been given."

CASE XVIII (Diuray).—A female with a generalized peritoneal echinococcosis, probably secondary to a cyst of the liver. In this patient, the abdomen was filled, stuffed it might be said, with cysts of every size, especially numerous in the omentum and pelvis around the uterus. But around these cystic tumors there were thousands of others resembling sago, which completely covered the peritoneum. These small nodules were merely cystic formations in the early phase of their evolution. Diagnosis: Dévé's echinococcal pseudotuberculosis.

CASE XIX (Villemin).—This was a case of multiple peritoneal hydatid cysts which had been followed for sixteen years. The onset began with sharp pain in the region of the cardia. Ten years later, at the time of the first operation, three to four hundred cysts were found in the abdomen. They varied in size and color. Some were greenish-black, others yellow, others clear and transparent. When all were collected in a jar they occupied a space representing about seven to eight litres.

Three years later, the patient almost died from comatous accidents, with relative anuria and severe albuminuria.

Villemin writes: "I was obliged to operate again on account of the continued increase of the abdominal development. Upon this occasion I found the entire intestinal surface, all the mesentery and all the peritoneal folds covered with thousands of small cysts looking like the tuberculous granulations of bacillary peritonitis."

Two years later, some room had to be made within the abdomen, therefore some more cysts were removed, but a week later the patient died from accidents of hepatic and renal insufficiency.

CASE XX (Piquet-Clays-Morestin).—Female, æt. twenty-seven years, in good health previously, was suddenly seized with violent pain starting in the epigastrium and then extending throughout the abdo-

men. This was followed by syncope, vomiting and fever. A physician summoned at the time made a diagnosis of peritonitis. The condition improved somewhat, but from this time on the abdomen increased in size and the general health declined.

Patient entered hospital the first time on September 8. The abdomen was very large, uniformly distended by a peritoneal fluid collection, offering all the signs of an abundant ascites. The general health was mediocre, the patient had become emaciated for several months, suffered from frequent diarrhœa and painful paroxysms which appeared to be related to the bad condition of the intestine. Examination remained negative as far as the liver, spleen and adnexa were concerned. Finding no good explanation for the ascites it was thought probably due to tuberculosis of the peritoneum, and as there was no doughiness or tumor, and since the fluid was free and considerable in amount, it seemed like a good case for operation.

An incision was made below the umbilicus and gave issue to several litres of bile. All the intestinal coils, all that could be seen of the parietal peritoneum was incrustated with small deposits of bile salts. The possibility of rupture of an hepatic cyst was thought of, but nowhere in the abdomen could an hydatid be seen; the liver itself was not large, so it was decided to close the abdomen and await events. The patient left the hospital in twenty days and returned to work soon afterwards.

Three years later she returned to hospital, stating that for several months past she had noticed that her abdomen was progressively enlarging and complained of painful paroxysms, digestive disturbances and emaciation.

The abdomen was deformed and lumpy. Multiple tumors with ascites. Various signs of compression, pain, constipation and œdema of the legs. A diagnosis was not made, but an exploratory incision was decided on. On opening the abdomen an ascitic fluid was found, but no bile. Multiple hydatid cysts varying in size from a walnut to an egg, scattered throughout the abdomen, above and below the liver, in the flanks, pelvis, greater omentum and between the intestinal coils. On the other hand, "on the intestinal coils a large number of small nodules the size of millet seeds were found; some were white and opaque, others gray and translucent. They looked so much like the granulations of tuberculous peritonitis that for a minute there was

a question whether or not the two morbid processes did not coexist."

Some of the cysts were excised, but their complete removal was out of the question. The operation had to be shortened on account of the patient's poor condition. The abdomen was closed with drainage.

A durable improvement ensued, but soon the abdomen began to enlarge again. The patient again entered hospital just four years later and at operation multiple cysts of the abdomen were found and were removed or incised and cleaned out. There was a cyst of the liver which was incised and drained. The operation had to be stopped after the removal of the principal cysts, but many were left behind. "The peritoneum was studded with cysts, most of them very small, the size of shot, and looked like fishsporn. The intestine in particular was covered with these small cysts." The general health improved, but it is to be feared that this is only a calm in the storm.

CASE XXI (Weber).—Female, æt. forty-three years. Suffered for some months in the abdomen, which slowly increased in size. Suddenly diarrhœa, vomiting and distention set in and a diagnosis of peritonitis was made.

On opening the abdomen a seropurulent fluid was let out. The intestinal coils were glued together by adhesions, which were freed. Evacuation of the fluid and closure of the abdomen without drainage. The operative results were mediocre; the patient was very poorly until two or three sutures gave way and allowed the exit of much pus. After this, amelioration was rapid.

Two years later the patient was seen with a hernia in the entire line of incision. In the right side of the abdomen there could be felt a movable, bosselated tumor having no connection with the uterus, which itself offered some lumps perceptible on palpation. There were also some small lumpy masses in the pouch of Douglas and to the right of the uterus. The diagnosis of tuberculous peritonitis was made, having the right tube and ovary as a starting-point. The abdominal tumor was supposed to be the omentum infiltrated with tuberculous granulations.

Operation.—Multiple cysts of the abdomen. Excision of the omentum and right adnexa containing cysts. Removal of a cystic tumor of the right broad ligament. The fundus uteri and pouch of Douglas were covered with very small tumors the size of millet seed that were left behind on account of the impossibility to remove them.

Recovery uneventful. The patient remained in hospital in order to watch the uterine tumors and those in the pouch of Douglas. These tumors increased in size and required a second operation some months later. Hysterectomy, removal of the remaining cysts. Recovery.

CASE XXII (Abadie).—Female, æt. thirty years, complained of uterine disturbances. Several tumors in proximity to the uterus could be felt or appeared to be one with it like a bunch of grapes glued to either side of the organ and depressing the posterior vaginal wall. Diagnosis: Numerous subperitoneal uterine fibroids.

Operation.—Omentum riddled with hydatid cysts, varying in size from a pin's head to a large egg. The mesocolon, lesser omentum and mesentery also contained numerous cysts of various size. "But what was especially strange, was the general aspect of both the parietal and visceral peritoneum. On the surface of the intestine and elsewhere was an abundant crop of whitish opaline vesicles which were hydatid cysts in the early phase of development and were quite comparable to a general tuberculosis of the peritoneum."

The omentum was excised. An attempt was made to remove the large cysts, but was given up for fear of dissemination. Recovery rapid.

The patient was kept under observation after she left the hospital. Little by little the cysts in the mesocolon developed and the abdomen became literally stuffed with multiple tumors whose presence gave rise to digestive disturbances from the resulting mechanical constipation.

The general health remained good for two years and then progressively declined, the exitus occurring four years after the operation, the patient refusing any further surgical interference.

Remark.—Abadie "believing that only a general treatment could give any chance of destroying the hydatids," advised "first a mercurial treatment and later on arsenic and sodium formiate" after the operation.

CASE XXIII (Cranwell).—Male, æt. thirty-six years, with an hydatid cyst of the liver, was punctured by a physician at the time the diagnosis was made. According to the patient, the puncture gave exit to a clear fluid, but immediately afterwards, the abdomen increased in size, while pain and malaise occurred obliging him to remain in bed for several hours.

Since this accident the abdomen had remained enlarged and he

suffered from sharp pain. Two months later patient entered hospital for operation. The under surface of the liver was covered with a large number of adhesions, and although no hydatid cyst could be discovered a large number of small tumors the size of millet seeds were seen scattered over the surface of the liver and omentum. They were white, and upon examination proved to be hydatid pseudotuberculosis of the peritoneum.

Recovery was uneventful. Two months later the patient again entered hospital, this time with a very apparent cyst of the liver. Laparotomy revealed an hepatic cyst the size of an ostrich egg containing a clear fluid; incision and interior of cyst swabbed with formol. Reduction, no drainage. Recovery.

CASE XXIV (Cochez).—Male, æt. sixteen years. Father tuberculous. Patient had measles at the age of ten, since which he has had frequent attacks of bronchitis and an enlarged abdomen for a long time.

In October the patient was in hospital for bronchitis, and shortly after he came in the abdomen swelled, and in a month's time it had reached such size that it was noted by the attending physician. Puncture was resorted to and gave issue to a few cubic centimetres of clear fluid. This first puncture was followed by a still more rapid increase in the size of the abdomen. From December to the following April six punctures were made without giving any relief to the condition. The general health became bad and emaciation set in.

In July, the patient entered hospital under Cochez's care, with a diagnosis of scrofula. The limbs were frail and the abdomen enormous. In the axillary and inguinal regions there were numerous enlarged lymphnodes. The abdomen was distended, smooth, and presented a collateral circulation.

Palpation of the abdomen revealed the presence of numerous nodules whose *ensemble* formed a cake similar to those found in peritoneal tuberculosis. The hereditary antecedents and the clinical signs presented by the patient were in favor of this diagnosis.

Operation.—Multiple hydatid cysts of abdomen, incision and excision of numerous cysts. Death on third day.

Autopsy revealed a large number of cysts scattered throughout the abdomino-pelvic cavity; multiple cysts of the liver, likewise perihepatic and perisplenic, etc. "The largest vesicles were the size of a

lemon and appeared to be contemporary with each other. Others were the size of a pin's head. The smallest, which were very numerous in certain areas, looked like tubercles.

CASE XXV (Le Nouëne).—Female, æt. twenty-six years, had complained for seven or eight months of pain in the hepatic region. Since this epoch she noticed that there was a bulging under the right ribs. A physician treated the patient for hypertrophic cirrhosis, while another made a diagnosis of hydatid cyst of the liver and advised an operation, which was refused.

In October the patient made a brusque movement in bed and was suddenly seized by a violent pain in the hepatic region and at the same time the swelling disappeared completely. On the same evening, the patient was taken with severe diarrhœa and on the following day the thorax and upper limbs were covered with an eruption of urticaria. From this time on the general health declined, the abdomen became tense and the patient commenced to cough.

The family physician had made a diagnosis of rupture of an hepatic cyst and the consultation with a surgeon advised at the time was postponed for two months, and Le Nouëne saw the case only at the end of December.

Examination.—The patient was in considerable distress with an enormous abdomen uniformly distended. The patient passed most of the time in bed. Examination of the abdomen revealed a generalized intra-abdominal fluid collection. There was an indefinite pain throughout the abdomen, apparently not more marked in the hepatic region than elsewhere. No œdema of the lower limbs. Heart normal; some dulness and dry râles over both pulmonary bases. Urine contained traces of urobilin, but no sugar or albumin. No icterus; no pain in shoulders.

Diagnosis.—Hepatic cyst ruptured into abdominal cavity.

Operation (on January 3).—Incision over hepatic region, giving issue to a yellow fluid free in the abdominal cavity. No adhesions. The liver appeared greatly enlarged, but even in outline. The gastro-hepatic peritoneum was red and covered with granulations the size of a pin's head which were confluent in this region, while some were scattered over the small intestine. The presence of these granulations and the even aspect of the liver at first led the surgeon to suspect that an error in diagnosis had been made and that the case was, in reality, a tuberculous peritonitis.

However, a needle was pushed into the liver, giving issue to a clear fluid which left no doubt as to the presence of a cyst covered by about one centimetre by the hepatic parenchyma. The cyst was injected with a one per cent. formol solution which was withdrawn in five minutes. The cyst was then incised and sutured to the abdominal wall after an examination of all the other viscera had been made and which only revealed the granulations already referred to. The areas of peritoneum most covered with the granulations were swabbed over with the formol solution. Recovery in seven weeks.

The patient has been seen several times since leaving the hospital. On May 20, she was in excellent health. Vaginal examination, which has been made five times since, showed that the uterus was free and revealed nothing in the pelvis. The general health is excellent other than for a little diarrhoea occurring occasionally. Three years after the operation blood examination gave the following results:

Weinberg's reaction was absolutely negative. This result was all the more distinct, because a normal human serum and an hydatid human serum taken as controls, each gave their characteristic reaction to this test.

The patient was seen four years after the operation at which time she complained of prolonged and severe metrorrhagia—ten days each month. The uterus seemed sufficiently large to suggest the presence of a fibroid. However, by rest and other treatment, the menses, although still abundant, diminished, and examination seven months later showed that the uterus was much smaller. The general health was otherwise perfect.

CASE XXVI (Sabadini).—Female, æt. thirty-five years, entered hospital for dull pain in the abdomen and stated that the abdomen had been enlarged for some little time. A physician had told her that she had a tumor in the pelvis and had advised her to go to a hospital.

Examination revealed a tumor in the iliac fossa and not in the pelvis. It was the size of a large orange, resistant and somewhat movable. Alongside this tumor it seemed as if other smaller ones could be detected. The abdomen was soft, the liver appeared to be normal and the patient had never previously suffered from liver trouble.

As in Algeria, hydatid cysts are common, and Sabadini's experi-

ence is extensive, he regarded the case as one of peritoneal echinococcosis and therefore decided to operate.

When the abdomen was opened the peritoneum was found slightly vascular with tumors scattered over the entire lower abdomen, especially in the right iliac fossa. In size they varied from a millet seed to a large orange. Only one was this size and occupied the upper ileocæcal angle. The others were the size of a filbert or almond. The millet seed granulations were very numerous and were particularly evident on the intestine. Larger cysts were found in the right iliac fossa and posterior surface of the pelvis.

The large cyst was punctured, then opened, swabbed out with sublimate solution and closed, as its removal would have been too difficult. It contained clear fluid. The majority of the smaller cysts were excised and the incisions in the peritoneum closed with catgut. The abdomen was closed without drainage.

The patient was discharged one month later in excellent condition, and as she has not since been heard of, it is probable that she has remained well, as she promised to return should any symptoms recur.

Pædiatrics

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THE PREVALENCE AND MANAGEMENT OF TUBERCULOSIS IN INFANCY *

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THERE is a common but totally erroneous impression among the laity that tuberculosis is frequently, if not usually, a hereditary disease. In point of fact, instances of tuberculous infection present at birth are so rare as to be looked upon almost as medical curiosities. Tuberculous parents, however, frequently bring forth premature, undernourished or weakling children who offer little resistance not only to tuberculosis, but to other infections as well. At all events, infection with the tubercle bacillus usually takes place some time after birth, and from one of two great sources, namely, exposure to another individual who is suffering from the disease, or from an infected milk supply. Of these, unquestionably the former is by far the more important, at least in this locality, and perhaps the explanation of the relatively insignificant rôle played by contaminated milk as a cause of tuberculosis in infancy may be found in the ever-increasing use of certified milk, obtained from tuberculin-tested cattle, and the common practice of boiling or pasteurizing milk for infants.

* (Read before the American Child Hygiene Association, Eleventh Annual Meeting, St. Louis, October, 1920.)

INFECTION ALMOST UNIVERSAL

It is a matter of common knowledge, repeatedly verified at the autopsy table and elsewhere, that infection with the tubercle bacillus is well-nigh universal among adults. It is equally well known that for the most part this infection takes place during the period of childhood, and, indeed, it is possible, by means of simple tuberculin tests, to show how the incidence of tuberculous infection gradually increases with the age of the children so tested. For example, at birth we find no positive reactions, at one year of age perhaps a few, and at ten to fourteen years 40 per cent. or more of the children react positively to tuberculin tests, thus showing that they have been infected with the tubercle bacillus. Indeed, in certain localities—notably some of the cities on the European continent—it is claimed that at ten to fourteen years, the number infected reaches a total of 90–95 per cent. In referring to such figures, however, it must be remembered that a sharp distinction is drawn between infection with the tubercle bacillus and tuberculous disease, and that many of these children will never show any ill effects from this infection, nor will they have the familiar signs and symptoms of tuberculosis or consumption.

THE DEFENSE MECHANISM

Ordinarily, the “dose” of such tubercle bacilli with which we are infected is a relatively small one, insufficient to produce the usual clinical evidence of tuberculosis, but sufficient to stimulate the body to produce certain protective substances against future similar infections. This probably constitutes a large part of the defense mechanism of the body against tuberculosis. The power of producing such protective substances or antibodies, however, is apparently acquired quite slowly, and the younger the child at the time of infection, the feebler his resistance to tuberculosis. Consequently the percentage of children who develop active symptoms of the disease after infection with the tubercle bacillus is much higher during the period of infancy than in later childhood. Furthermore, the mortality among infants infected with tuberculosis is appallingly high, being 78.7 per cent. during the first year of life, according to our figures,¹ and 57.4 per cent. between the ages of one and two years.

FREQUENCY OF LESIONS

Statistics as to the frequency of tuberculosis in infancy, as shown by autopsies, vary considerably. For example, Holt² quotes the figures from three New York hospitals, with a total of 4046 autopsies on children, nearly all of whom were under three years of age; of this number 538, or 13 per cent., showed tuberculous lesions, and in over two-thirds of these, this disease was the chief cause of death. In Feldman's³ autopsies 43 per cent. of the children dying between one and two years of age showed tuberculosis, and Hamburger⁴ in Vienna, and Comby⁵ in Paris, each found 40 per cent. at this age. Such figures, although of little value in fixing the true incidence of this disease, nevertheless emphasize its importance as a common cause of death in young children. Perhaps a better conception of its relative frequency may be gained from the statement that during the past year about 3 per cent. of the babies admitted to the infant ward of the St. Louis Children's Hospital were found to be suffering from active tuberculosis, and this despite the fact that the majority of our cases in infancy are so-called "feeding cases," that is, children with some intestinal disorder who are not sick in the ordinary sense.† In short, then, we may say that tuberculosis is not only of relatively frequent occurrence in infancy, but assumes an augmented importance at precisely this age, because of a mortality which is never approached at any subsequent age period.

PREVENTION AND MANAGEMENT

Because of the strikingly low resistance of infants to tuberculosis, and the consequent high mortality at this age, the *prophylaxis* is of paramount importance. This should include first of all the prompt removal of the infant from the tuberculous environment, whether the potential source of infection be the mother, other relative, or friend. The child should be guarded against even the briefest exposure to all persons in whom there is a suspicion of active tuberculosis. In this connection it should be emphasized that nursemaids and other

† This figure includes only those cases in which the diagnosis seemed quite certain. Had we included all infants with positive skin tests, in whom activity of the lesion seemed highly probable because of the age of the patient, the percentage would have been perceptibly higher.

caretakers are occasionally an unsuspected source of such contagion. Secondly, every young child should be protected as carefully as possible against exposure to the acute infectious diseases, but especially those, like measles and whooping cough, which are known to diminish further the resistance to tuberculosis. The baby should have a limited number of trusted caretakers, and the promiscuous handling and kissing by relatives, friends and admirers should be discouraged. If it is learned that exposure has taken place, efforts should immediately be redoubled to build up the general resistance of the infant before the development of symptoms. He should be given the benefit of an antituberculous régime, as strict as though infection were known to have occurred. And finally, the value of breast milk, in increasing the resistance of the young child to all infections, cannot be over-estimated.

EARLY DIAGNOSIS ESSENTIAL

Once infection with the tubercle bacillus has taken place, the chief hope of the infant will rest on early recognition of this fact, and the inauguration of a proper antituberculosis régime. The diagnosis of tuberculosis in its early stages is frequently exceedingly difficult, even when signs of activity are present, and is, of course, usually impossible before this time. During the period of infancy, however, early recognition of the infection may be immensely simplified by the use of the simple and harmless tuberculin skin tests. Either the von Pirquet, or the intradermal reactions may be used, and a positive result at this age is presumptive evidence of an active tuberculous infection somewhere in the body. This test should be a routine procedure in all infant welfare conferences, clinics, hospitals, etc., and should be repeated perhaps every six months on each infant. Children from a tuberculous environment should have their records so tagged or marked as to draw attention constantly to this increased hazard.

PREVENTION OF MASSIVE DOSE INFECTION

Once the disease is present, the child should be removed from the infective zone to prevent "massive dose" infection, and a strict antituberculosis régime should be instituted. The latter should include removal of the child to the country, when possible, and pro-

vision for supplying an abundance of fresh air, day and night, without, however, subjecting the infant to the rigors of highly inclement weather. Every precaution should be taken to prevent exposure to other infections, and a scrupulous attention must be paid to the problem of nutrition. Success will only be attained after a long struggle against heavy odds and many discouragements, but with proper coöperation between physician and caretaker, and the adoption of some such routine as has been outlined, there would seem to be no question but that the present high mortality of this disease among infants can be very materially reduced.

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Industrial Medicine

INDUSTRIAL SURGICAL CLINICS

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BULLETINS TO THE MEDICAL PROFESSION OF THE STATE

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BULLETIN No. 1

POTT'S FRACTURES

POTT's fracture may be produced: (1) By the leg being fixed and some moving body catching the foot on the inner side and carrying the foot outward. (2) It is most often produced by a fall where the foot becomes fixed and the driving force through the tibia is directed toward the internal malleolus, forcing the foot outward. The internal malleolus is torn from the tibia by the internal lateral ligament. We may have nothing more.

The next step, we have the inferior tibiofibular ligament torn with a spreading of the tibiofibular space, only.

In a typical Pott's, the force is sufficient to carry the astragalus outward, breaking the fibula from one to three inches above the distal end and the astragalus is carried outward one-half or more its width. This relaxes the articulation of the foot and the foot drops backwards, or is pulled backward by the tendo achillis. The internal malleolus is carried from its normal position outward with the foot.

So we always have an outward and backward dislocation of the foot in addition to the fracture of the tibia and fibula.

Reduction.—Reduce the fracture as soon as possible giving general anæsthesia.

Semiflex the leg at the knee.

Sit down, placing your knee against the tibia just above the internal malleolus.

Grasp foot, one hand over the os calcis and sole of the foot, the other hand over dorsum of foot.

Evert the foot or abduct it from you, so as to free the internal malleolus.

Pull the entire foot directly toward you as far as it will come (it will not come too far on account of the fibula stopping it, because the external lateral ligament is not torn). After you have pulled the foot sufficiently toward you to replace the dislocated astragalus, invert the foot slightly. This drives the fragment of the internal malleolus back into position.

Completely dorsoflex the foot so that you have corrected the backward dislocation. If you can completely dorsoflex the foot, the backward dislocation has been corrected. If you cannot dorsoflex the foot, the backward dislocation has not been corrected. Hold the foot at a right angle to the leg, slightly inverted, maintaining this position.

Prepare plaster-of-Paris dressings made of many folds long enough to reach from the popliteal space down over the heel and extend three or four inches beyond the toe over the sole of the foot, and wide enough to come up to the malleoli on the sides of foot; lay a piece of sheet wadding over it wide enough to finally fold over the leg. Fold this around the leg, heel and foot and hold the foot in perfect line, applying a wide roller bandage for coaptation, holding the limb *yourself* until this cast has hardened. If you are satisfied with the position of the foot and the alignment, then fold the sheet wadding over the leg and put on the plaster dressing over this one in the ordinary way.

After Treatment.—If the backward dislocation is not completely reduced, the man is left with a painful foot, is unable to dorsoflex same and he is not able to step over the foot in walking. If the foot is left in outward rotation or abduction, the strain on the internal lateral ligament is increased and the pressure against the external malleolus increases the width of the joint and this condition is very disabling, especially to a laboring man. The man should not be

allowed to put too much weight on a foot following a Pott's fracture until it has had sufficient time to heal. He should be directed to raise the inside of the heel about three-eighths of an inch and it is also well to put at least a quarter of an inch on the inner side of the sole of the shoe, so as to throw the weight-bearing axis in the right direction on the foot to prevent this abduction becoming increased.

You will often see a very bad outcome as a final result from neglecting this after treatment and care in a case that was almost a perfect result at the time the surgeon removed the cast. In my opinion this is the cause of many bad end results.

Plaster bandages should be 6" wide. Begin over foot and carry each roll up, over and above the ankle so it will not break at a joint in the plaster near ankle. Do not rub the plaster after applying, as doing so draws the plaster to the surface, leaving no plaster within same.

The sketches, here presented, are an average of results as we see them. They should be much improved. Eighty-five per cent. of Pott's fracture cases, handled with care, should produce practically a normal result so far as function is concerned. Our observation is that at least ninety per cent. of them are not good functional results. These are not the worst cases, nor the best, but an average selected because they illustrate the three principles that I have attempted to call attention to.

"Illustration No. 7 shows method of cutting and folding the material for traction. It should be made from heavy non-elastic material.

"Illustration No. 8 shows method of application to the leg and should extend from a foot to sixteen inches beyond the foot so that it may be tied as shown in Illustration No. 4.

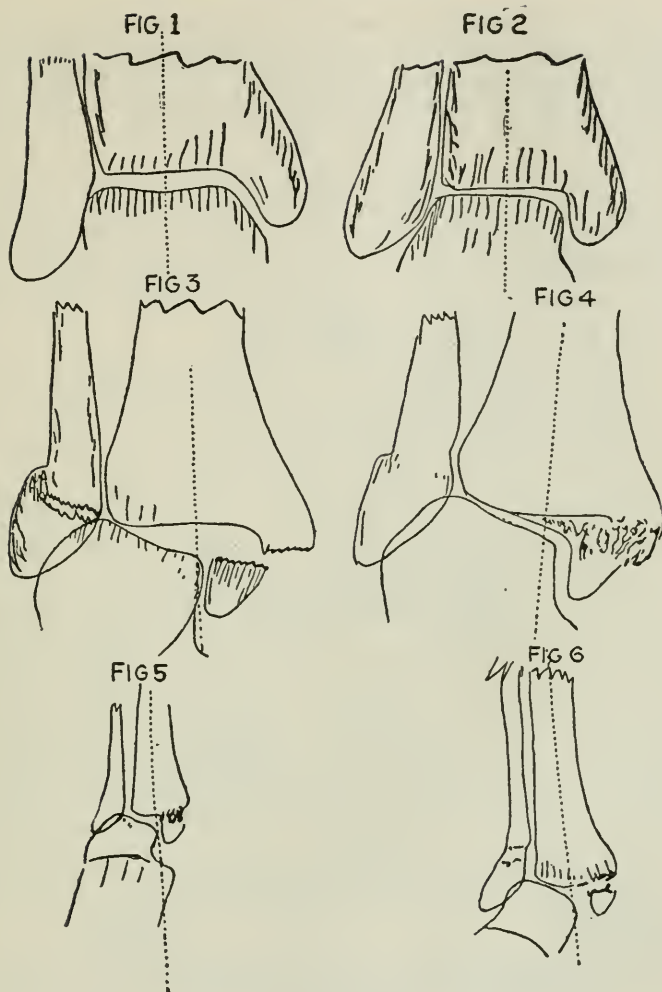
"Illustration No. 9 is canvas spat and straps applied to foot, used in first aid in connection with Thomas knee splint to make extension during transportation of patient to hospital, instead of side bar splints and bandage.

"Illustration No. 10 shows the Thomas knee splint with towels pinned over side bars to carry the limb and keep it in line and can be adjusted after splint is in position by pinning ends over the side bars of the splint.

"To apply No. 7 extension as illustrated in Fig. 8, use the following:

Resin	50
Alcohol	50
Benzine	25
Venice turpentine	5

Powder the resin and add half the alcohol. Dissolve, then add the turpentine and benzine, then the remainder of the alcohol. This is known as Page glue. It is



Pott's Fracture.

FIG. 1 and FIG. 2 are normal. FIG. 3, typical Pott's Fracture failure in reduction because the surgeon did not abduct the foot before he attempted to reduce the dislocation of the astragalus so as to clear it. In my opinion from x-ray (showing no impaction) he abducted or inverted the foot first, driving the fragment of the internal malleolus up into the articular surface of the tibia, thereby blocking his reduction of the astragalus and left it in this position thinking that he had pulled the astragalus over to its normal place. FIG. 4 is the end result of this case which is very, very common. The foot is not a bad one, but it is not perfect or what it should be. You will note that there is callous thrown out in the articular surface between the tibia and astragalus, altho the internal malleolus is united it is not in normal position. FIG. 5.—Fibula was not broken. Internal malleolus torn off and inferior tibiofibular ligament torn, separating the tibia and fibula with outward dislocation of the astragalus. It was never reduced. Tibia and fibula were not held together; astragalus not in normal position; callous poured out into the tibio-astragalus articulation; was allowed to walk too soon; did not have inside of heel of shoe and sole raised; weight bearing line carried to inner third of astragalus; badly crippled. FIG. 6.—Same condition as 5, except fibula broken. Anterior inferior tibiofibular ligament torn; weight bearing axis or line does not strike the centre of astragalus but is carried to the inner margin of the astragalus which strongly everts the foot. This foot is equal to about fifty per cent. of an artificial foot.

applied to the limb with a brush, making the last strokes of the brush upward. Then apply the extension illustrated in No. 8 and a roller bandage over top of same. The ends for extension are folded over the distal end of the splint and tied as illustrated in No. 10, using a Spanish windlass to produce your extension." (Hull.)

BULLETIN No. 2

ALIGNMENT AND EXTENSION OF FRACTURES OF THIGH AND LEG

The essentials are:

1. To establish, by X-ray, an accurate knowledge of the condition to be dealt with—making a careful study.
2. A general knowledge of the deformities that are likely to follow the particular fracture.
3. The best method of preventing the deformities, both functional and anatomical, that may ensue in this particular case.

In all fractures involving the thigh or leg there are two essentials which must not be overlooked in order to obtain a good average result; these are *alignment* and *extension*. To fail in either one of these leaves the man a cripple to some degree. In order to succeed, the extension must be *continuous*, not *intermittent*. This is also true of alignment. A splint that has these two qualities present all the time within itself is absolutely essential. The Thomas splint, with some modifications to suit individual cases, has these two qualities, and is suitable only for hospital treatment of all fractures of thigh and leg, but is also one of the best first aid methods for transferring a patient to a hospital, as it allows extension and perfect alignment with no restrictive band around the leg to interfere in any way with the circulation.

For first aid treatment, use canvas spat illustrated in Fig. 9, for extension, use Thomas splint illustrated in Fig. 10. By turning up the spike in the extension bandage you will get sufficient extension to prevent further damage at site of fracture. If it is compounded, of course, you would apply aseptic dressing. In this way you have a man ready for transportation, and as comfortable as he can be made, and he can travel almost any distance without added damage to the soft parts or blood vessels.

To use the Thomas splint for hospital treatment as illustrated in Fig. 11, you will see that there is also an elevation of the limb. The end of the splint is suspended by a strip of canvas, while the

canvas strip shown glued to the sole of the foot carries and pulls the foot in the proper forward position and maintains proper alignment. This extension should be applied as early as possible before the muscles have had time to contract, which they always do unless there is extension enough applied to tire them and keep them relaxed. In using the extension strips in Figs. 7 and 8 for fractures of the thigh, carry the side straps well up above the fracture. This gives additional pull and better alignment by reason of the lateral pressure applied

FIG. 7

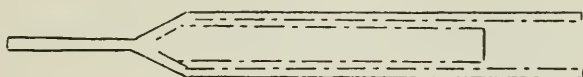


FIG. 8

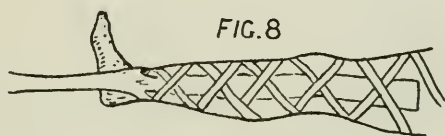
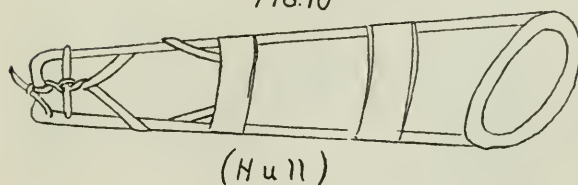


FIG. 9



FIG. 10



through the strips. This also obviates the objectionable pull through the knee joint, with consequent relaxation of these ligaments which often remain relaxed if the extension is applied below the knee.

For fractures of both bones of leg at middle or lower third where they override, the best form of extension is that recommended by Groves modification of St. Clair skate. Take 12 to 15 thicknesses of plaster gauze; make a low slipper, fit around sole of foot; when dry remove; apply to foot with brush, acetone-celluloid glue, replace

and attach straps to this slipper for extension. It will carry a ten or fifteen pound weight.

FORMULA:

Acetone	6 to 12 per cent.
Celluloid q.s.	100 per cent.

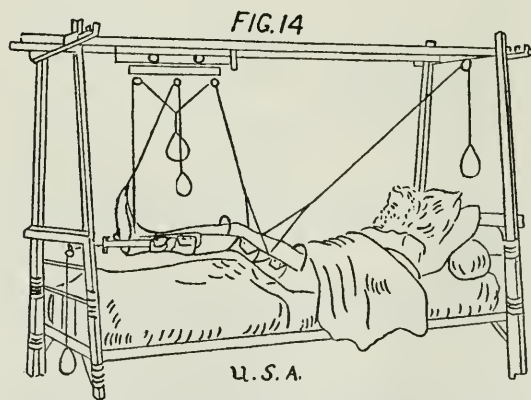
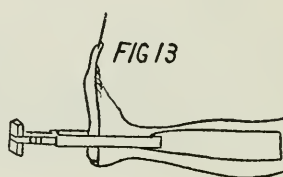
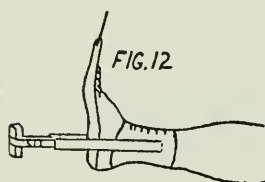
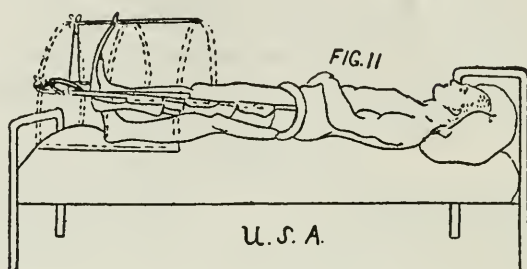


FIG. 14.—Method of treating fractures of the tibia and fibula by suspension and traction. The limb is suspended in a Hodgens bent to an angle of about 135° . Traction in this case is made (as shown) with straps glued on to the leg for extension and to the foot for alignment.

Figure 12 shows the application of a canvas spat. We also illustrate in Fig. 12, a method of applying spat with weight extension or the windlass extension with Thomas splint and canvas glued to bottom of foot for alignment and to prevent footdrop, or if you prefer, Fig.

13 shows strips glued to the side of the leg which extend above the fracture and pull through the frame adaptable to either weight extension or the windlass extension, with canvas glued to bottom of foot for alinement and to prevent footdrops. These extensions can be stuck on with Page's glue, or acetone-celluloid glue, which is preferable, because of being non-irritant even after long application.

Intermittent extension and its results are well illustrated herewith. We get history like this: "My leg pained me so I had the nurse put a chair under the weight at night so I could sleep—I had a flatiron on for weight, weighing 8 pounds, etc."

Fig. 14 illustrates the Hodgen splint applied and Balkan frame and trolley bar suspension for the treatment of fractures between the knee and ankle. Fig. 11 method being used with elevation and counter weights. Some surgeons prefer the Thomas splint, allowing the end of it to come down against a board at the foot of the bed, then using a roller and weight instead of the windlass; this makes as good an extension as when the windlass is used, but the patient doesn't have the freedom of movement in bed that he has with the windlass.

Every surgeon doing industrial surgery should familiarize himself with the principles of the Balkan frame and its use in treatment of fractures; not only of the thigh and leg, but also of the arm. We deem this to be one of the outstanding forward steps in the treatment of those fractures and an apparatus that should be in every hospital in the state. The Balkan frame is susceptible to such adaptability that will permit the adjustment of the end of the bone which can be controlled to that which usually cannot be controlled, by this way overcoming or taking advantage of the usual rotation and abduction of the upper segment, and affords the best method of effecting both *alinement* and *extension*, which is the subject of this bulletin.

RADIOGRAPHY

The X-ray plates received by this department from the various X-ray operators throughout the state are many times of no diagnostic value. The main causes are: (1) Under exposure, (2) Over exposure, (3) Improper development, (4) Insufficient washing.

The intensity of exposure of a plate varies:

(1) Directly as the time of exposure.

(a) With the machine set the same way, ten seconds gives twice as much exposure as five seconds.

(2) Directly as milliamperage.

(a) All other conditions being equal, 40 M.A. gives twice as much exposure as 20 M.A., for the same length of time.

(3) Inversely as the square of the distance from the target to the plate.

(a) With the target fifteen inches from the plate, four times as great exposure is made as when the target is thirty inches from the plate.

(4) Direct as the square of the voltage, which in self-rectifying machines, may be measured at the spark gap.

(a) Roughly estimated, multiplying the spark gap measured in inches by ten, and adding ten, gives the number of kilo-volts used. Thus a four-inch spark gap gives fifty kilo-volts.

(b) A six-inch spark gap gives nine-fourths the exposure of a four-inch spark gap.

The length of the exposure must be in proportion to the square of the distance from the target to the plate.

Distance 10 "	Time 1
Distance 20 "	Time 4
Distance 30 "	Time 9
Distance 40 "	Time 16
Distance 50 "	Time 25

To obviate under- and over-exposure use a long target distance, say 30", because if you use a 10" distance with one-half second normal exposure, and you give one-fourth second, you have decidedly under-exposed your negative; if you give three-quarters of a second, you have decidedly over-exposed your negative, but if instead, you move your target 30" away, then your time to correspond would be four and one-half seconds to get the same result as at 10", and if you happen to make it four seconds it would not be under-exposed, and if you made it five seconds it would not be over-exposed, and the detail is much better from the fact of getting a sharper shadow, as the sharpness of the shadow increases with the distance of the target from the subject and plate. These factors should be taken into consideration when making plates.

There can be no hard and fixed rule for taking radiographs. The exposure must be varied to accommodate:

(1) The size, weight and age of the patient.

(a) Obviously, it would require a greater exposure for a large man than it would for a small one.

(b) Similarly, the penetration necessary for an elderly person would over-expose the plate for a child.

(2) Local conditions must be taken into consideration.

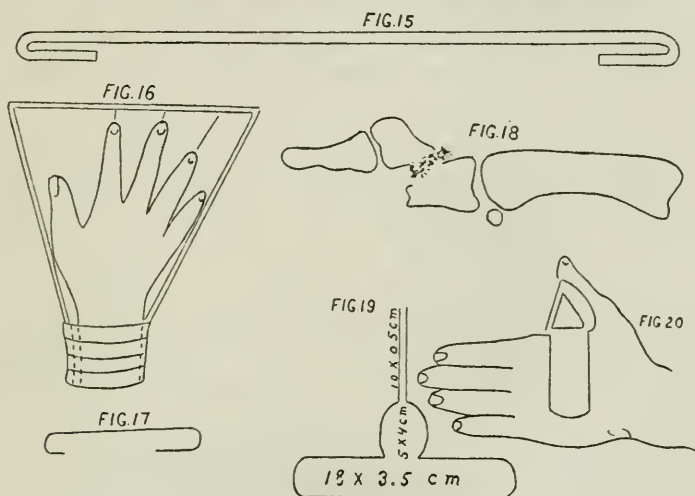
(a) Theoretically, a developer of fixed temperature is ideal. Practically, this is not always possible. A slight difference in the exposure of a plate should be made to accommodate the speed of the developer, which is changed by the temperature.

(b) A rapid exposure is sometimes necessary where a patient is liable to move, whereas, a longer exposure using less power is better for the machine and gives better results.

In thin plates some help may be gained by using a magnifying glass in reading the plates, as in several instances by this means we have detected a fracture shown in plates which were sent in with the reading, "no fracture."

The extension method of treating fractures of the fingers or metacarpals, which is a very good one, is called to your attention in Fig. 16. Fig. 15 shows a piece of heavy wire bent at both ends which permits it to be applied as shown in Fig. 16, the ends being fastened at the wrist by plaster-of-Paris bandage, making a very secure dressing for applying extension. Extension can be applied by fastening strips of adhesive plaster to the fingers, or by drilling a hole in the finger-nail and using a small clip as illustrated in Fig. 17, making extension through the use of the finger nail and clip.

Fig. 18 shows a fracture of the first phalanx of the thumb and end results. Fractures of the metacarpal of the thumb are best treated by extension, but fractures of the first phalanx of the thumb are best treated by the splint as shown here in Fig. 19. This is cut from galvanized iron, and Fig. 20 shows the application of



20 or 22 G. Gal Iron

Fractures of fingers, metacarpals and fractures of forearm.

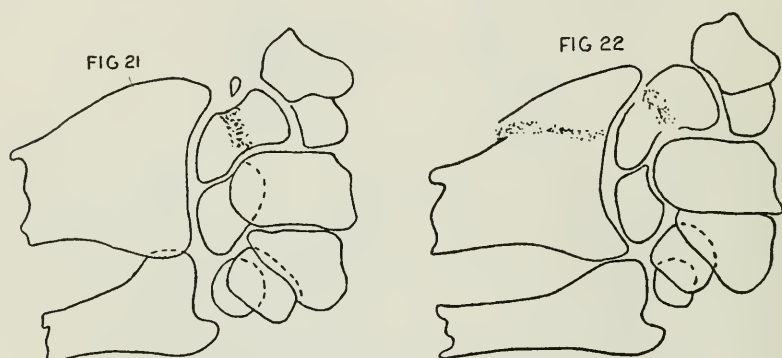
same. A fracture of the first phalanx of the thumb as shown here, treated in this way would not give an end result as shown in Fig. 18, even in the hands of a novice. It is needless to say that this man's thumb was a total loss.

FRACTURES OF CARPAL BONES

Fractures involving the carpal bones, as observed in this office, are very common occurrences (notwithstanding the fact that Warbasse's surgery of 1918 states, "it is not a common injury"). A fracture through the middle of the carpal scaphoid is as common as Colles' fracture, and, in fact, it is often concomitant, but more especially a fracture involving the styloid process of the radius. We have seen a great many where there was no other injury with the scaphoid broken in two pieces, often one of the pieces dislocated. This is a common injury a man receives in cranking a car when it back-

fires. The scaphoid is pinched between the os magnum, which receives the force of the blow, and derives the scaphoid back against the styloid process of the radius. This is plainly shown in Fig. 21. It may also occur as the only fracture when a man falls striking on his hands, especially if the driving force through the radius is directed toward the ulnar side.

Fig. 22 shows a fracture through the centre of the carpal scaphoid, and also a fracture of the styloid process of the radius—a common result when the violence is sufficient to produce the fracture in both bones. The cause, however, is the same in each. Figs. 21 and 22 were in the same man, Fig. 21 being the left arm and Fig. 22 the right. This man fell some distance, striking on both hands. The



Fracture of Carpal Scaphoid and fracture of Styloid Process of Radius.

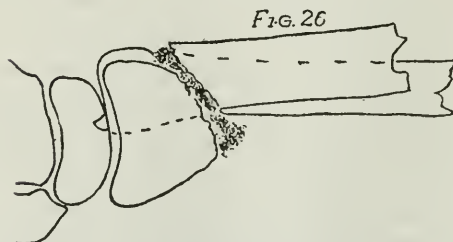
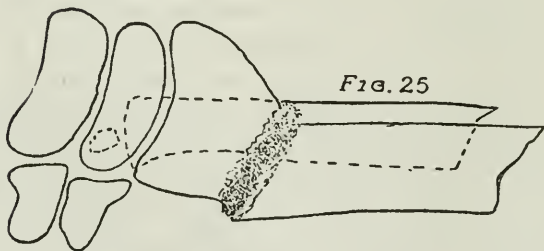
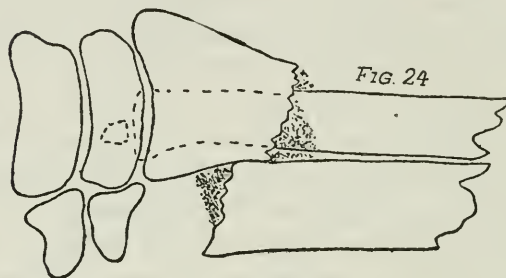
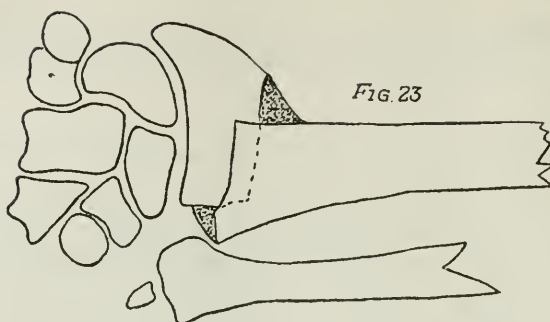
next in frequency is a fracture of the semilunar. Then we have seen a great many fractures of the os magnum, but they have always been due to direct violence. The fracture of the scaphoid is usually very disabling in its after results. Treatment of same requires a great deal *more attention* than is given to it at present. It seems to be looked upon rather lightly, owing to the fact that surgerys are comparatively silent on the subject. Where there is one piece of the scaphoid dislocated laying on top of the other, which is usually the distal end, it should be removed. A number of cases of this kind have a bad, disabling wrist, and almost useless hand as result of same. On removal of the dislocated piece, pain was relieved and function of the hand much improved. My personal opinion is where the scaphoid is broken across, as illustrated here, with no displacement of fragment, it should be immobilized for a period of three weeks, leaving

the fingers free. Then begin active movement, but the patient should not return to work until this bone has had sufficient time to become united.

COLLES', OR FRACTURE OF THE DISTAL END OF THE RADIUS

We will not discuss how this fracture is produced, as it is too well known. The first essential is a radiograph to determine the exact condition to be dealt with. Second, a complete reduction—not a “useless pretense.” A surgeon who thinks he can take hold of the hand of the patient with the “shake-hand” method and reduce a Colles's fracture is doomed to failure and chagrin. On confirming his reduction by X-ray, he will have remorse of conscience on finding that he did not change the position at all. On making a radiograph, if you find a fracture with no displacement and good alinement, let it alone. The usual deformity produced by the distal fragment riding, either partially or entirely, on top of the proximal end of the radius must be reduced into normal position. This cannot be merely pulled and pressed into place by pulling on the hand. There is too much giving in the way of extension in the carpal bones and it does not break up the impaction at site of fracture, so if the distal fragment is riding above the proximal fragment, give the man an anæsthetic, have an assistant take firm hold on the forearm, and by taking hold of the hand and the *distal fragment*, hyper-extend the *distal fragment* at *site of fracture* and abduct it toward the ulnar side, not in the wrist joint alone, but at site of fracture also, to unlock the fragments and relax the dorsal muscles and periosteum. In this position, apply your extension and crowd the distal fragment down to lock it in position. Then, by forcible flexion of the wrist and *distal fragment*, you can reduce the deformity and replace the same.

This fracture may involve the radius only, but in a large majority of Colles' fractures the styloid process of the ulna is torn loose from the shaft by the pull on it through the lateral ligament, to which it is attached. Where this happens the Colles's fracture is much more serious than where it does not take place. If the styloid process is not fractured, it is not necessary to evert the hand toward the ulnar side, but in cases where the styloid process is involved, the hand must be carried well to the ulnar side, to allow it to unite, if possible. If it does not unite the hand has lost one of its best sup-



FIGS. 23, 24 and 25, show an unreduced Colles'. It is not possible for this man to flex his wrist at all. Fracture at this location, however, does not always result in the distal fragment riding above the proximal end of the radius, as we see them riding under the proximal end as FIG. 26 shows. In this case, of course, the reduction is just reverse to the other. In fractures involving the distal end of the radius in all of its forms, look for fracture or involvement of the scaphoid.

ports, and we will have the deformity, which is so often seen, the hand carried to the radial side.

The test to determine whether the fragment has been fully reduced is to *fully flex* the hand at *the wrist*. If the hand flexes normally the reduction is complete. If you are unable to fully palmarflex the wrist, the reduction is not complete.

Splints: Take two wooden splints long enough to reach from the ends of the fingers to the elbow, pad them and place one on the palmar surface and one on the dorsal surface of the forearm, using a tight circular bandage and leave it four weeks or longer, then if the man hasn't a worse disability than he would have had with no treatment, it isn't your fault.

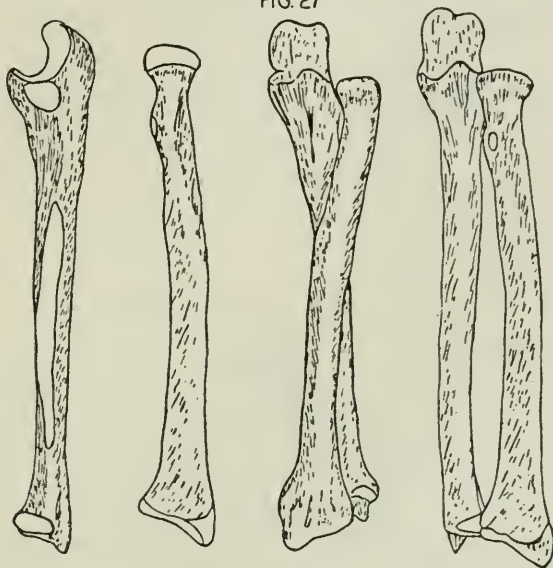
It appears that not all the surgeons appreciate just where such treatment, as here mentioned, leads them, or what actually happens, and do not go deep enough into the subject to keep them out of trouble in the future. Any individual will do well to turn back to the subject of physiology and pay special attention to circulation and interference with it and the lymphatic system, and what this leads to—ischemia, fibrosis, myositis, etc. Some fail to appreciate the fact that all of this can be started in the first day or two of treatment and it may be impossible to stop it after that time. I wish here to call your attention to some remarks made by Hessert. "The disability following a Colles' fracture is not the result of bony displacement as much as the result of improper treatment. * * * you can have a Colles' fracture six weeks still showing enormous radial and backward displacement, with perfect function." (He advises against operating in these cases.) "We see fractures properly reduced cosmetically with terrible deformity of the hand and disability for months and months. Why? Because, in the first place, the doctor may have put on a plaster cast from the elbow to the finger-tips and left it on a month or six weeks. If you want to produce a half-year's disability, do this. * * * putting them on too tightly for a few days will do the same thing, even after the most perfect reduction. * * * tight splints and bandage may cause ischemic palsy. The use of metallic bodies, like the Lane plates, on the outer side of live bone in the treatment of fractures is bad enough, they are fast being supplanted by autogenous bone-grafts." Dean Lewis in speaking of Lane's plate—"there is only one place for it and that is in discard."

After complete reduction the fragments have very little tendency, if any, to become displaced. Observation has convinced me that the best splint is made by taking a plaster-of-Paris bandage and folding eight or ten folds long enough to reach from the carpometacarpal articulation to the junction of the middle with the upper third of the forearm. Fold this around the palmar surface of the forearm, fitting it to same. Make another narrow one reaching from the same position on the dorsal surface of the hand to the junction of the middle, with the upper third of forearm and place a roller bandage around these two splints until the plaster sets, then take a knife and trim the plaster around the thumb so as to give the thumb free motion, and also trim it out over the distal end of the ulna and replace this cast, leaving the hand and thumb entirely free. Direct him to continue using the fingers and hand. This splint maintained for ten days, then removed every day and passive motion first, with later, active motion, and three to four weeks as the limit of splint retention, has produced best results as we see them here. The older the individual, the greater the danger of fixation of the hand and fingers. There is no splint made for ready use, that is a perfect splint for a fracture of this kind, so the sooner they are all discarded, the better for the injured men. The rule is, with a great many, to spend about fifteen to twenty minutes in reducing and caring for a fracture of this kind and then forget it. This manner of treatment should be a thing of the past.

First, we call your attention to Fig. 27. You will notice that the ulna is practically a straight bone, that the radius is curved and that in the normal function of the forearm, the curved radius rotates around the straight ulna as a door swings on a hinge, so it is very essential to keep the ulna as straight as possible, and the radius away from it, so as to give it clearance. When we have a fracture of one or both of these bones in the shaft, the pronator quadratus muscle pulls the lower fragments together and obliterates the interosseous space. If this deformity is not corrected, we will not have rotation in the forearm after union has taken place, so the first step in looking after a fracture of this kind is to pronate and supinate the forearm so as to clear it, then splint these fractures in *complete supination* padded flat splint so as to crowd the radius away from the ulna and fixed in such a way that there is no *encircling bandage* or *constriction*

around the forearm, as they will overcome your anteroposterior pressure. If so you will either have the radius pull in against the ulna, or the ulna pulled in and bowed and *its* straight line destroyed. One or both of these things is most likely to happen—either will destroy the possibility of rotation after union has taken place, if they do not become attached together by callous, which we too often see, as shown in Figs. 28 and 29. Both of these cases had complete loss of rotation of the forearm due to the crooked ulna and callus in interosseous

FIG. 27



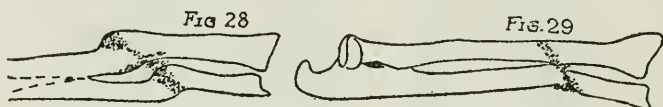
Fractures of the shaft of the ulna and radius.

space. You will note in Fig. 29 that the radius, which is normally a curved bone is straight, and the ulna which is a straight bone is curved.

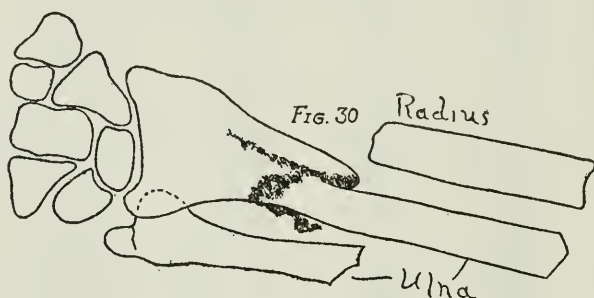
Your attention is directed to Fig. 30, which may happen where we have a fracture of both bones put in a circular plaster bandage around the arm, which tends to pull both bones together, and with their inclination, like a drowning man, to "grab on to the nearest thing," in this case united to it, as clearly shown in this radiograph. You will note that the *radius* is united to the *ulna* leaving the proximal end of the radius free, and the distal end of the ulna free. This fracture was put up in a circular plaster-of-Paris dressing. Too

much care cannot be given to this particular point in handling a fracture of this kind. It is needless to say that the hand should not be included in the splint, but given free use, which was done in this case and the hand condition is fair and will improve.

For fractures of the forearm, the best splint is a flat board, applied anteriorly and posteriorly, with padding between the boards to preserve the interosseous space and *these boards should be wide enough* so as to take all the *lateral pressure* off the forearm and allow for swelling. The board should not extend beyond the proximal third of the metacarpals and should be firmly pressed together and held by



Radius and ulna joined by callus.



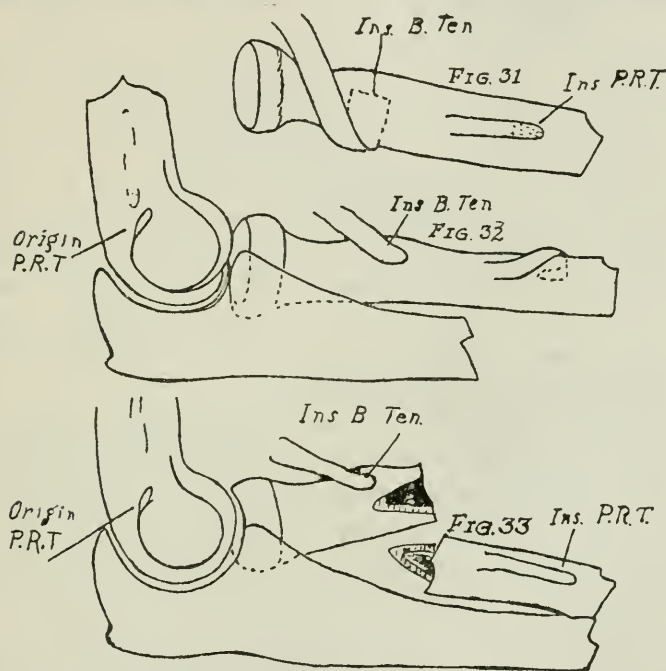
False union of radius and ulna.

adhesive strips, not tight enough to produce ischemia, and should be seen by surgeon in ten hours and every day for the first four or five days thereafter.

I call special attention to fracture of the shaft of the radius between the insertion of the biceps and insertion of the pronator radii teres shown in Figs. 31, 32 and 33. We find that eight out of ten of these fractures are treated in a way that shows little or no thought of the action of these two muscles, or what you might call the mechanics involved in the mechanism of pronation and supination.

In this fracture we show the end results with the callous formation left out, so that it illustrates what happens more clearly than when the callous formation, which was large, is shown. (This case was treated by a well-known surgeon.) By looking at Fig. 33 you will note that the proximal end of the radius is completely supinated

and flexed as far as the muscle and fascia of the forearm will admit, due to the action of the biceps muscle and the supinator radii brevis (this is the end of the bone which you cannot control). The lower end of the radius is pulled close to the ulna and pronated by the action of the pronator radii teres and the pronator quadratus. The hand remains in complete pronation. In a case of this kind, you will find that *active supination is lost*. In passive pronation and



Fracture of radius.

supination the *head* of the radius does not revolve. You will note that in this particular fracture the bone was broken in such a way that it clearly shows the rotation of the two ends, hence, you cannot control the proximal end of the radius; so you must place the distal end (this is the end which you can control) as nearly as possible in conformity, to the normal, with the proximal end.

This is done by fully flexing the forearm with complete supination of the hand, then splint to preserve the interosseous space between the distal fragment of broken radius and the unbroken ulna, with *wide board splints* as other fractures of the forearm. This particular

fracture was put up with the forearm at right angles and the hand in complete pronation. It united in this position so rotation of the forearm was entirely lost, giving the man a badly disabled forearm.

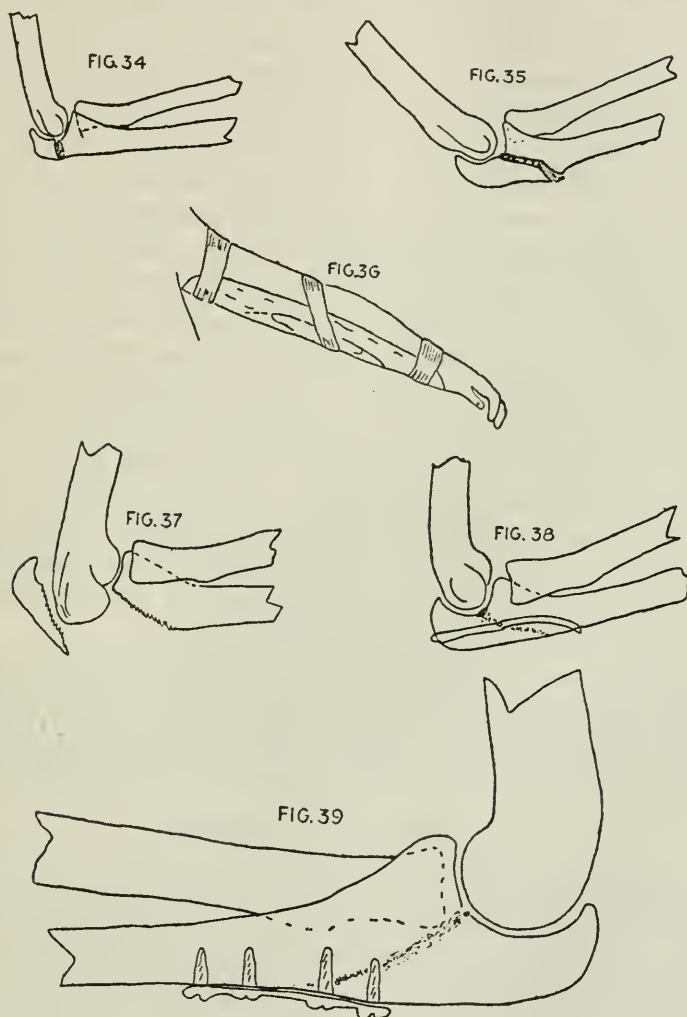
FRACTURES OF THE OLECRANON OF THE ULNA AND CORONOID

This fracture varies greatly so far as displacement is concerned. The larger majority of them are not badly displaced and these do best with little fixation by splints, or at most, not more than a week or ten days. Then begin passive motion, followed by active, and continue this daily. After three weeks time from the date of injury, following this line of treatment, the functional results, so far as the arm is concerned, are practically normal. However, there are some where the displacement is considerable. We illustrate two of these fractures in Figs. 34 and 35 which were complete fractures, so far as the bone was concerned, but with comparatively a small amount of separation. These were treated by splint and adhesive bandage, as shown in Fig. 36, with complete function of the arm. In some cases there is great separation of the tricepital fragment from the shaft and usually these are compounded.

Fig. 37 is a compound fracture as shown here. Four or five days later, it was wired as shown in Fig. 38. No infection followed and a temporary splint was applied for ten days, then the splint was removed. He had passive motion for the next five or six days, every day, and splint was replaced. At the end of fifteen days the splint was removed entirely and active motion was allowed. This wire was never removed. The man had no disability to the arm. However, we have seen a number where the displacement originally was not so great, although the fractures were complete. These were treated by being placed in splints at a right angle and kept there for five or six weeks, resulting in almost a complete ankylosis of the elbow joint. In a young individual, fixation is not so serious as it is in a person at middle life or later, as active use of the arm will make it gradually improve, but in the old man, it will not improve to a great extent. As a rule, they will not persist in the use of same, and in fact, there is greater danger from callous being poured into the joint which cannot be ironed out by active and passive motion unless it is begun very early.

These simple or compound fractures with great separation of the

olecranon, are best treated by being brought together and wired, or a sliding bone transplant drilled and held in place by kangaroo tendon (some use kangaroo tendon only). No matter what the



Fractures of the Olecranon.

suture material is, it must be put in superficial to the articular cartilage or it will increase the risks of a stiff joint. Some use plates, but from observation here in industrial work the Lane plate should be in the discard, in my opinion, for any and all fractures. Taking all

of the cases and considering the greatest common good to all, you can only arrive at one conclusion, and that is the abandonment of the Lane plate entirely.

Fig. 39 is a compounded fracture of the olecranon in which a Lane plate was used and, so far as the plating and the union of the fracture is concerned, was ideal in result, but this arm was put in plaster cast extending from the wrist to the upper third of the humerus and left in place for five weeks. The plaster was removed, then put back on for some two weeks more, and then removed. At the end of four months' time from date of accident, he has almost complete ankylosis of the elbow joint. It is fixed at a right angle with not more than five degrees of motion. There has also taken place a lot of fibrosis in the muscles around the elbow, so they are hard and ropy. He has almost a useless arm at this time. In this case after the plate was applied, in which it shows that the screws were well put in, the plate and the radius would have held the olecranon in position, owing to the *long* oblique fracture which gives plenty of leverage against the triceps muscle. Two weeks would have been sufficient to keep the arm fixed and active and passive motion should have been commenced and continued daily from that time on. *"Fibrous union with good functional result is a much better end result than solid bony union and ankylosed joint."*

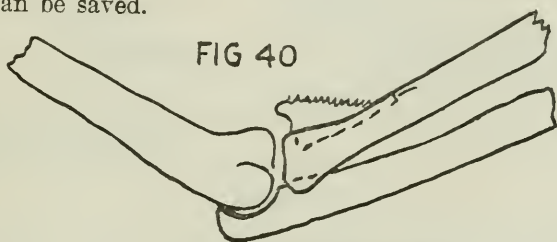
In this class of fractures there is only one excuse for using a plaster cast *encircling* the arm and that is, that it gives a sense of security to both the attendant and patient while it is in place, but it covers up what is actually taking place until it is too late to remedy.

FRACTURES OF THE CORONOID

Fracture of the coronoid process of the ulna is barely mentioned in some surgeries, and other authors do not mention it at all. There have been eight, to our knowledge, in the state of Washington in the last nine years, usually produced in backward dislocation of ulna. We illustrate this fracture in Fig. 40. You will note on looking at the radiograph that the coronoid process seems to be displaced far above the normal position. However, this is not true, as shown in other plates of this same case, because this radiograph was made by myself, especially to show this fracture up. The target was placed midway between the flexor surface of the forearm and the dorsal

surface, or at what might be said about 45° from anterioposterior. This position, of course, carries the shadow of the coronoid above the radius, and shows the fracture very well. They seem not to be especially disabling, however, and in my opinion, are best treated with acute flexion at the elbow (because the brachialis anticus tends to pull it upward) and strong supination of the forearm, maintained in splint about 20 days, then passive motion and later active motion. The end results in this fracture have been good, when treated in full flexion and supination, otherwise there is a tendency for the ulna to slip backward and be displaced.

The Legislature of 1919 placed upon the State Medical Aid Board the duty of furnishing artificial limbs, and we have found in the last nine months experience, that a large per cent. of the amputations are not made with any other thought than to save all of the limb that can be saved.



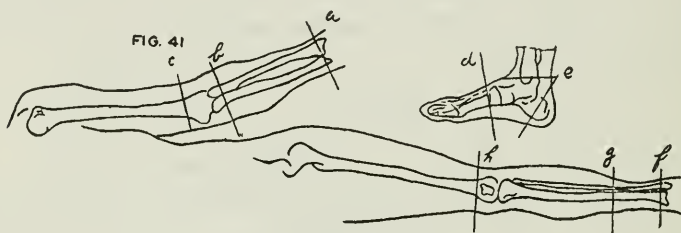
Fracture of coronoid process of ulna.

We have seen many amputations to which it was impossible to fit an artificial limb at all, for instance, an amputation of the hand at the proximal third of the metacarpals. This amputation makes it absolutely impossible to fit the man with a Dorrance hook or an artificial hand. It cannot be securely fastened to him, and if so it would make his arm about two inches longer than the other one. So, if you have to go up to the metacarpal region of the hand and are going to include the thumb, then amputate as shown in (a), and from this point in the amputation of the forearm, save every bit you can in length up to an inch and a half below the elbow. If shorter than an inch and a half as shown by (b), then go to (c). In amputations of the arm, save all the bone that you can, because a stump of four inches from the shoulder is a great aid in handling an artificial arm. We have had several hands *reamputated*, because a good artificial hand, nowadays, is better than a badly crippled hand.

In amputations of the lower extremity, the amputation made on

the foot, as marked in (*d*) is only fair, because the anterior support of foot is hardly long enough, especially if the man has a long heel. An amputation through the foot, posterior to the metatarsal articulation, makes it impossible to put an efficient foot on the man, so, if you have to go back to that, then the operation marked (*e*) is preferable, because you divide the tendo achillis and transplant the os calcis under the tibia, which gives the man a direct weight-bearing line, and artificial limb manufacturers make a limb for this particular amputation that is fairly good, but it takes the *ankle support* away.

A good stump at (*f*) usually gives a direct weight-bearing surface to the stump and is a good one. Some claimants have such tender skin, that the scar will not stand the direct pressure unless it is



Amputations.

covered with heavy tissue like the sole of the foot, and then it should have no scar in it. The most serviceable leg, if you have to go above this point, is to amputate at (*g*), that is at the junction of the middle with lower third. This, however, requires a hinge at the knee and a binder around the thigh, while the other operations at (*e*) and (*f*) may not. If you have to go higher than (*g*) save everything that you can up to two inches below the knee-joint, that is, if you can keep this fragment free so it won't become ankylosed or pulled out of place by the muscles, which it is very apt to do. Do not amputate through the *knee-joint*, or through the condyles of the femur, because the bone is too wide and prevents the hinge-joint at knee from being properly applied in the artificial limb, so if you have to amputate at the *knee-joint*, go to (*h*). A very good way is to transplant the patella under it. In amputating the thigh above this line, save all the bone possible, because even a stump of a couple of inches, or amputation at the lesser trochanter, will help retain an artificial limb.

FRACTURED PATELLA

L. L., male, aged forty years.

Three years ago patient had a fracture of the left patella, which he said was operated within a week of the time of occurrence. He now has a horse-shoe shaped incision, the convexity upwards. See Fig. 42. The patella is elongated to about two-thirds more than its normal length and the space between is filled with callus, which apparently is dense, since it allows no motion. Voluntary flexion of the knee is limited to about fifteen degrees. Patient resists examination considerably. When engaged in conversation he allows about thirty degrees of flexion, at which time the patella and the tendon becomes tense and the joint comes to a sudden, sharp stop.

The incision with the convexity upwards is an unusual one, although it is mentioned in some text books. The horse-shoe shaped incision with the convexity downwards, with the flap not too long, is the conventional incision. The flap with the convexity downwards allows for more perfect circulation than with flap with the convexity upward, and is not so apt to slough. It also places the scar in a location in which it will not become adherent to the structures which will interfere with future motion of the knee.

The authors do not use either of these incisions, in view of the fact that the horse-shoe shaped incision, with a considerable flap, stands a fair chance of sloughing at the edge where the circulation is poor and does not give any better exposure of the knee-joint than the straight perpendicular incision over the midline of the patella. The skin can then be retracted to both sides, the clots emptied from the knee-joint and the patella and lateral ligaments fully exposed. There has been considerable discussion as to the best methods of repairing a patellar fracture, and a full discussion of these would take more time and space than is available in an issue of this sort. Suffice to say that it is quite generally accepted by authors at this time, that a purse-string suture entirely surrounding the patella on a horizontal plane with the fractured surfaces brought into firm contact by pressure at the time of suturing, with a subsequent, and if anything, more important suture of the capsular ligament on each side of the patella, is the suture which is most commonly accepted as sufficient for all types of fracture. Fractures by muscular violence are more or less transverse, but fractures by direct violence or a com-

bination of direct and muscular violence are often quite comminuted. The purse-string suture holds fractures of this type in perfect apposition, eliminates the necessity of drilling through the patella where Kangaroo tendon or heavy braided silk are used, maintains the apposition for sufficient length of time to allow the patellar ligament to heal, and at least a fibrous union to take place in the patella itself.

It was the opinion of the late Dr. John B. Murphy, and many others, that a suture of the capsular ligament, with such a purse-string suture around the patella, was sufficient even in the absence of the patella to maintain a satisfactory union between the quadriceps tendon and the patellar tendon, and allow normal strength and motion at the knee-joint. It is extremely doubtful whether bone formation in the patella is anywhere near as prompt as bone formation in other bones, it being a sesamoid and having rather poor osteogenetic powers. It is only after a number of months that the fibrous tissue formation which joins the fragments, has lime salts deposited in it sufficient to be called real callus.

Considerable discussion has come up from time to time as to the time in which these patellar fractures should be operated. It seems to the authors, after having operated on a considerable number, that there is only one hard and fast rule; that all signs of laceration of the skin, or parts around the knee shall have been cleared up and a normal, smooth skin, which can be made surgically clean, be present at the time of operation. If this is seen to, it would appear that whether we operate on the third day or the twelfth day is of little consequence; the only difference being, that the blood clots which are present in the joint become more firmly organized and somewhat absorbed as time goes on, and may be a little harder to remove from fractured surfaces of the patella. This is a matter of no importance providing the wound is kept surgically clean.

The after treatment in fractures of the knee-joint, as fractures in other joints, is extremely important. The earliest institution of passive motion is extremely important. If the suture of the tendon and the patella have been firm, there is no reason why passive motion should not be instituted within the first week; support of the patella, above and below, while this motion is being established will take the strain off the line of suture. Careful attention should be given by the surgeon, or a skilled assistant, to this motion for the first month,

after which active motion can be instituted without fear of doing serious damage. The authors place the knee in a slightly flexed position of about fifteen degrees, following the operation. This is a much more comfortable position for the knee, and by bringing the leg into full extension each day and replacing it in fifteen degrees of flexion, a full twenty-five degrees of flexion can be obtained without injury to the muscle, inasmuch as it is kept in a state of pressure tension and is not allowed to fully contract, as it would if the leg were held in a straight line.

It has not been found necessary to do a bone graft in any case of fracture of the patella, and it seems to the authors a far-fetched theory that we take a piece of hard cortical bone, transplant it to a cancellous sesamoid bone which has an extremely poor blood supply at best and expect to do any considerable amount of good. There is no weight, whatsoever, placed on the patella; it is simply a sliding mechanism to enable the patellar tendon to functionate more perfectly, and to fill in the interspace between the condyles and the articulating surface of the tibia when the knee is in flexion, acting as a pulley for the quadriceps in bringing the lower leg into line with the femur; and if the ligament can be made to take the pull, the only function of the patella is to act as a pulley. It would seem, therefore, that a transplant of fascia from the quadriceps tendon to the patellar tendon, if necessary, would be more in the light of assisting nature in the way she wants to go, than putting in a piece of cortex into bone which is not of this type.

TUBERCULOSIS OF THE EPIDIDYMISS—CLAIMED ACCIDENT

A. R., age thirty years, male, married, two children, ages four and six.

History.—The man claims that two years ago he was loading iron bars on a truck when one got caught between his legs, squeezing the testicles. This was not a blow, just a slow force. He continued to work without trouble. The next day he noticed right testicle was swollen. This swelling was, according to his own description, as though a marble was attached to the side of his testicle. It was moderately painful. He reported to the company doctor, who treated it with a suspensory. It remained swollen for two months, and he had a slight white urethral discharge just before the swelling disappeared.

One year ago this same swelling occurred again. It came on gradually, not following an injury, and it reached the size of his fist. It again lasted about two months; noticed the urine was white several times and then gradually disappeared. The present time is his third attack and came on about eight days ago, slowly enlarging. He stopped work then.

Examination.—Patient is a well-developed young man who looks as though he had lost some weight. He states, on questioning, that he has lost about forty pounds.

Eyes, teeth, tonsils, and throat are negative.

No glandular enlargements.

Lungs were carefully examined, but were entirely negative.

Heart sounds normal.

Abdomen negative.

Testicles not enlarged, but the right epididymis is enlarged and hard. This swelling in the globus minor is about the size of a marble, and the globus major is the size of a walnut. It is not nodular, does not fluctuate, and is smooth and hard.

The right vas for about one inch above the epididymis is hard and slightly thickened.

Rectal Examination: The prostate is slightly enlarged, much indurated and slightly nodular—the left lobe is larger than the right, both seminal vesicles are indurated.

Urine examination was negative for albumen, sugar or pus cells.

Wassermann was negative with both plain alcohol and cholesterinized antigens. Gonococcus complement fixation test was negative.

Diagnosis.—Tuberculosis of the epididymis.

This was based on the following points:

1. History of swelling being chronic with cloudy urine before disappearance.
2. Sterile for three years.
3. Epididymis involved and not testicle which is common in this disease—the epididymis being usually involved before the testicle and early chronic lesions are often localized here for some time.
4. Prostate indurated and enlarged but not painful.
5. Wassermann and gonococcus complement fixation tests negative.
6. Loss of weight.
7. No chancre or urethral discharge.

Operation.—The right epididymis and vas deferens were removed (epididymectomy) and wound closed without drainage.

Pathology.—The epididymis when opened was found to be a sack tensely filled with cheesy, light green pus.

Sections showed tubercles with giant cells.

Guinea pig injections of the pus showed glandular enlargement with tuberculosis in these glands. Smears of pus did not show tubercle bacilli.

Relation to an Accident.—In nearly all these cases an accident is claimed. This case had no witnesses to the accident. He continued to work, the testicle did not actually swell as it would in a traumatic orchitis.

This man has been sterile for three years, showing the probability of the existence of this disease before the claimed accident.

Tuberculosis of the testicle or epididymis is usually secondary, in fact, most authorities express doubt if it is ever primary here. As it is usually secondary to tuberculosis of prostate, and as this man has tuberculosis of the prostate, it is reasonable to suppose that the disease existed before the claimed accident. This is especially so, as the history shows that these swellings came on slowly.

COMPOUND COMMINUTED FRACTURE OF THE HUMERUS WITH MUSCULOSPIRAL INJURY

F. C., male, aged twenty-eight years.

In April, 1919, this patient was thrown against a post from an automobile, received a compound comminuted fracture of the humerus with an injury to the musculospiral nerve. An incision was made at the point of fracture, the ends of the fragments thoroughly cleansed, some loose bone removed and the wound left open. No attempt was made at that time to find the nerve in view of the fact that the wound was an infected one and no good could be accomplished by further exposing the nerve to traumatism in the presence of infection, which was extremely good surgical judgment. The arm was placed in a splint and the hand in a cockup splint to hold the fingers in full extension and the wrist in forty-five degrees of extension. The wound was dressed daily and continued to discharge for five months; inasmuch as there was not available any electrical apparatus in the place where the patient was located and the wound continued to discharge, the musculospiral paralysis not clearing up, patient was sent to our clinic for treatment.

An X-ray was taken at the time of the first examination by the authors, which showed an osteomyelitis, involving the upper end of the lower fragment.

An external longitudinal incision was made between the biceps and the triceps, the fragments exposed, the necrosed bone and sequestrum removed by the use of sharp chisels only; curets not being used. The musculospiral nerve was not sought out in the case of this opera-

tion on account of the infection, but an electrode was used in the wound to determine, if possible, the proximity of the musculospiral nerve and if possible, whether there was any break in continuity or whether the damage was simply that of a traumatism.

At the time the patient came to Wesley Hospital he had complete atrophy of all the extensor muscles of the forearm, but inasmuch as he had had the cockup splint applied, there was no contracture of the flexors. During the course of the operation enough reaction was obtained in the extensors by direct stimulation very near to the musculospiral and above the site of the fracture, to lead us to believe that the nerve was not severed, but traumatized. No hope for a union between the fragments was held at the time of this operation. The arm was put up in internal and external splints, which after the operation could be removed daily for dressing. The wound was kept wide open. At the time of the operation the wound was filled with a solution of iodoform and ether, and packed with iodoform gauze. The wound healed rapidly, being entirely closed in about four weeks, during which time the patient had had electrical treatments and massage applied to the extensor muscles of the forearm in the following manner. The Bristow Coil, described in a previous article, was used as a means of stimulation, one electrode being placed over the motor point of each extensor group, the current turned on and the wave, controlled by the core, being moved in and out of its container, which gives a sinusoidal effect. The extensor muscles in this way were developed until in about eight weeks the arm was round and the muscles reacted very satisfactorily to the electrical stimulation. When the wound was healed, the electrode was placed over the musculospiral nerve above the site of fracture and the effect of the electrical stimulation could be seen in the extensor muscles, beginning to react to voluntary efforts on the part of the patient. He was allowed to use the coil himself and allowed to return home, and in four months from the date of operation, wrote that he was gaining full control of the extensor muscles and in six months came back with a normal hand and forearm.

The fracture was still ununited, as shown in the X-ray, with no sign of effort at any considerable bone formation, with a considerable space between the fragments.

In six months from the time the wound had been firmly healed,

FIG. 42.



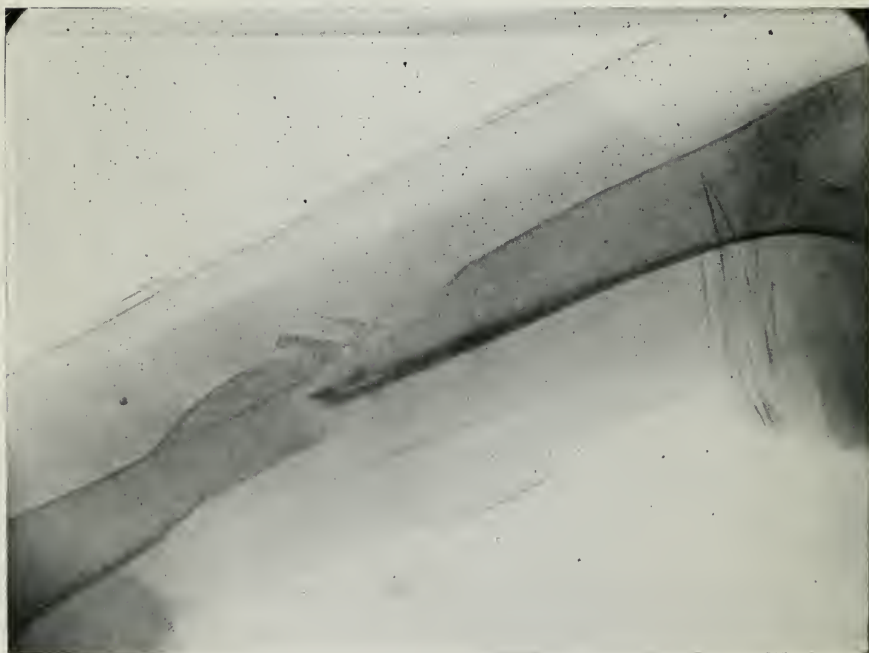
Fractured patella after operation with horse-shoe shaped incision, the convexity upwards. Flexion of the knee is limited to 15°.

FIG. 43



Compound comminuted fracture of the humerus after second operation with ivory screw to hold fragments.

Fig. 44.



Compound comminuted fracture of the humerus. This healed after second operation and developed secondary infection twenty-eight days after the operation. This shows the partial absorption of the ivory screw.

Fig. 45.



Diathermy used in non-union of fracture neck of the humerus, showing correct connections with the Victor Waniz High Frequency Apparatus.

the patient came back and was subjected to two weeks of very vigorous massage and manipulation of the injured part, in an effort, if possible, to see if there were any remaining infection to stir it up, so that it would show itself before any further operation. There was no reaction whatsoever and it was decided to unite the fragments by a bone graft taken from the tibia.

An incision was made through the old scar, the ends of the fragments freed and the eburnated bone over the ends chisled off. In the process of this chiseling a pocket was encountered which looked suspiciously like a walled off infection, and in view of this fact it was decided not to do a bone graft, but to shorten the arm and screw the fragments together. Consequently the ends of the fragments were dove-tailed and brought into apposition and a single ivory screw driven through to hold the fragments in apposition. See Fig. 43. The wound healed by primary union and in two weeks the patient was allowed to return home, wearing a splint.

In exactly twenty-nine days from the date of the operation, the patient returned with a history that twenty-four hours before the arm had begun to pain and that within twenty-four hours a blister appeared on the outer surface of the arm and when the splint was removed, a discharge of pus was found on the dressing and two sinuses leading down through the old scar to the fracture were discovered. The whole scar, within one and a half inches in both directions of the fracture, sloughed out within the next ten days, and there was a very free drainage of pus from the wound. The bones, however, remained in apposition, the wound was packed and kept open and the splints remained in apposition. Drainage continued and at the end of a month, a small piece of bone was discharged from the wound. At the end of this time, it being two months from the date of operation, treatment with diathermy was established in the hope of promoting circulation and causing a reaction. With the wound still open in the form of a sinus leading down to a fracture, this treatment was continued for two months, at which time a marked increase in callus formation was seen in the X-ray and the patient stated that his arm felt stronger; that is, he did not feel any tendency to spring in the middle of the humerus when he flexed the elbow. In two weeks from the time, examination showed that there was firm union and that there was sufficient callus formation to allow the

patient to discontinue treatment and return to his home. There was no effort made to remove the sequestrum which was undoubtedly present, and there will be none until such time as the X-ray shows firm callus in sufficient quantity to warrant removing the sequestrum.

About twelve weeks from the time of the operation, part of the ivory screw was removed from the sinus and showed about 50 per cent. absorption, see Fig. 44, which further demonstrates our contention over a period of fifteen years, that ivory is absorbed and in the presence of infection is cast off as is catgut, kangaroo tendon, autogenous bone graft or beef bone; its advantage being, that in a clean wound it does not act as a foreign body and is gradually absorbed, and in an infected wound it is treated as any other substance which is not actively supplied by circulation.

Comments.—Good surgical judgment was exhibited in this case in not trying to search out and ascertain the damage done to the musculospiral nerve at the time of the injury in the presence of infection. This, of course, saved the patient probably permanent crippling, or at least a very much longer period of disability and further operating procedures involving the nerve itself. The very best that could have happened would have been having the nerve involved in the scar tissue, which would have necessitated going in to relieve it from its imbedded position in the scar tissue and transplant to a new bed.

Placing on the hand and wrist a cockup splint which prevented contracture of the flexor muscles and overstretching of the paralyzed extensors, prevented deformity and hastened the recovery after electrical stimulation was applied. Had electrical stimulation been applied to the extensor muscles immediately or shortly after the injury and their tone and substance kept up to normal, it is probable that the function in these muscles would have returned much sooner. However, this was impossible, and everything was done which could have been done at that time and in that locality.

In mentioning the operative procedure, attention was called to the fact that sharp chisels were used in removing the dead bone and not curets. It is, of course, the universal opinion of those who do considerable bone surgery, that dead bone cannot be removed satisfactorily by any form of curetting. Only the necrotic surface of the bone is removed when a curet is used, and it is only by the aid

of a sharp chisel that the deeper layers of healthy bone can be reached and the necrotic bone removed. There is another extremely important reason why a curet should not be used; that is the danger of spreading infection by opening up blood vessels and causing a shower of bacteria to be thrown into the general circulation. A surgeon who is familiar with the feeling of dead bone and healthy bone can, with a great degree of accuracy, tell the difference immediately, in the feeling of the chisel in the bone and it serves as a guide to the depth and the amount of bone to be removed. The thinner the chisel, up to a reasonable limit, the more accurately can one tell regarding the density of the bone with which one is in contact. The sharp chisel also somewhat seals the ends of the blood vessels as it is driven in and, therefore, has a tendency to wall off rather than open up the circulation to infection; thereby preventing emboli. The chisels used by the authors are ordinary carving chisels of various shapes and sizes, which were purchased at a hardware store, at a cost considerably less than those supplied by the surgical instrument houses and on an average, much more effective.

Diathermy was used in the after treatment of this case with very favorable results. Diathermy is a term used, meaning the heating of the tissues by electrical currents of high frequency. We use for this treatment the Victor Wantz High Frequency Apparatus. The electrodes are metal foil, and are so placed opposite each other, that the distance directly through the tissues between them is shorter than the surface distance between the edges of the electrodes on either side. We used in this case electrodes 2" x 2". Great care should be used in placing these electrodes, that they are smooth and make perfect contact throughout, to avoid concentration of the current at any one point. The amount of heat should be regulated to the tolerance of the patient. Note in Fig. 45 the manner in which the apparatus is connected. The current passes through the meter and is thus regulated. This is direct diathermy.

This is the second case that we have used the direct diathermy in which we have seen and proved by X-ray, that bone lesions were improved. Dr. A. B. Hirsh in *Surgery, Gynecology and Obstetrics* gives his experiences with this current in some bone lesions while chief of the Physiotherapy at General Hospital 41, at Fox Hills, and quotes several cases that diathermy influenced favorably.

Fig. 46 shows the amount of callus formed in this case after the use of direct diathermy, as compared with X-ray in Fig. 44 taken at time of infection.

A CASE OF BAD JUDGMENT

J. S., male, aged thirty-eight years.

Five years ago this patient was scalded by hot water coming in contact with his right leg, from about four inches below the knee to the ankle. Part of the wound healed satisfactorily, but there was left an area on the inner surface of the leg extending around the tibia about eight inches long and four inches wide, which stubbornly refused to heal.

Thiersch's grafts were used on several occasions without effect, probably because no attempt was made to clean the wound up and make it sterile before the graft was made. The patient was, however, able to walk and had no disability in the knee or ankle. While there was some œdema when the patient was on his feet, it was not serious. It was finally decided by the physician in charge, to do a flap graft to cover this lacerated surface. He, therefore, took from the flexor surface, under the knee, a long flap running up to about the knee-joint, with the pedicle downward, swinging it around and covered over the lacerated surface. He then attempted to bring the two edges of the incision from which the flap has been taken, together. This it was impossible to do; the sutures pulled out, the flap became infected and finally sloughed, and he then had a raw area beneath the knee and the same old ulcer which had existed previously. In the process of healing the leg became flexed, and the surface gradually contracted until the return circulation from the lower leg was interfered with by the cicatrization of this area, and a tremendous œdema of the leg below the knee occurred with further sloughing of the previously burned and subsequent healed area. The illustrations, see Figs. 47 and 48, will give some idea of the tremendous disability which occurred as a result of, not the injury, but the operation to cover up the injury.

Comments.—It should have been recognized by the individual treating this case, that the soft, flexible skin beneath the knee is as much a specialized skin as is the heavy skin on the bottom of the foot, and that any scar placed in the front of a knee, or elbow, or axilla, is bound to be a painful condition and that a loss of flexibility is bound to occur in the joint, which is in close proximity to this scar. In the case of the knee the great blood vessels lay superficially, the

FIG. 46.



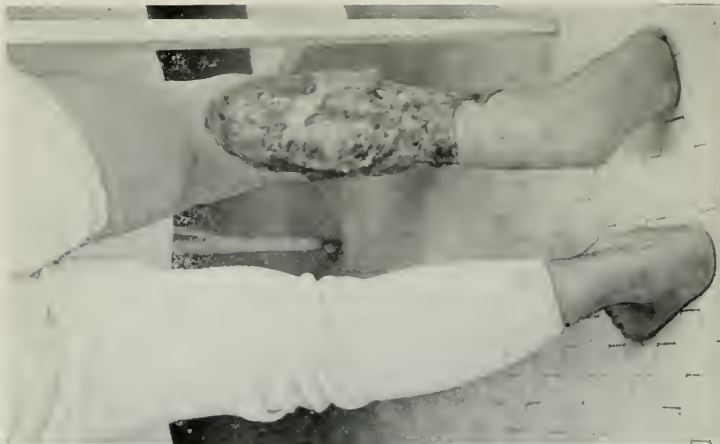
Compound comminuted fracture of humerus showing callus formation after diathermy treatment.

FIG. 47.



A case of bad judgment. Scald of lower leg — a flax graft taken from under the knee followed by sloughing and an open contracting ulcer.

FIG. 48.



A case of bad judgment showing rear view of same leg as FIG. 47, an amputation was necessary.

returned circulation is none too active in any part of the leg, and especially below the knee, so that any interference with this returned circulation is sure to cause a tremendous œdema. It takes a very few ounces of pressure to entirely block a vein in any part of the body and it takes practically no pressure at all to block a vein in the leg when the patient is in an upright position, because the tendency is all toward stagnation instead of active return. It was found necessary to place a flap graft over this area, the flap should have been taken from the opposite leg where there was normal, healthy circulation and normal, healthy tissue. If the flap had been taken from the opposite leg there could have been a wider base left for circulation and if the flap had sloughed or had failed to unite on the edge of the wound, the whole flap would not necessarily have been sacrificed; the edge could have been removed and reapplied to the area from which it was taken without serious loss.

In this case it was necessary to amputate the man's leg above the knee and even then great difficulty was experienced in getting a flap sufficiently long to cover the stump. The amputation was successfully performed and barely enough skin obtained to make a satisfactory stump at a point just above the condyles of the femur, which will provide for a sufficient artificial limb leverage and is the most satisfactory sort of thigh amputation. It is understood, of course, that the bone is amputated above the flare, where it becomes cancellous tissue.

DIRECT DOUBLE RUPTURE OF THE FASCIA OF THE EXTERNAL OBLIQUE

E. B., male, aged fifty-eight years. Occupation, coal miner.

Patient was caught between a car and the side of a mine, the pressure being exerted largely on the upper part of the abdomen. The car moving slowly, patient got a grip on an under edge of it and at the same time it was pressing him in the upper part of the abdomen, he gave a violent lift to throw it over and had a stinging pain in both sides of the abdomen. He was not able to continue work on account of the pain; went home, rested for a number of days. After the soreness had subsided, he returned to work but found that he could not lift without severe pain in both sides of the lower abdomen. Said he noticed bulgings which he had not noticed before; the bulging running obliquely from a little above the anterior superior spines downward and forward towards the pubis. He was examined by several medical men, who made the usual examination for inguinal hernia; and in view of the fact that no hernia was found and the patient, although not being fat, standing in a rather stoop-shoulder position with the abdomen prominent, overlooked the fact that there was an abnormal bulging in the abdominal wall and failed to examine above the usual location for inguinal hernia.

He came to our clinic on November 8, 1920, claiming that at this time he had pain constantly when standing. The longer he stood, the more severe the pain grew. There was no bulging at the external ring, but when the patient was put upon his back and the examiner's fingers run from the upper part of the abdomen, straight down in a vertical line, to a point about two inches above Poupart's ligament, there could be felt a weak place in the abdominal wall on both sides. When the patient was on his feet and asked to cough or exert intra-abdominal pressure, a distinct impulse could be felt over this area. As a result, a diagnosis was made of rupture of the fascia of the external oblique.

The patient was operated on January 5, 1921, the interval between the first examination and the operation was occupied in the cleaning up of a severe case of pyorrhœa and abscessed teeth which were in his mouth.

At the operation, incisions were made about two inches above the ordinary incision and in a line parallel with the ordinary incision for inguinal hernia. The fascia was exposed and a longitudinal split in the fascia appeared, which extended from the conjoined tendon upward about six inches, in a line parallel with its fibres. This was overlapped, an imbrication operation being performed and repeated on the opposite side, which was found to be almost identical. Two weeks were allowed to elapse for recovery in bed and the patient allowed to go home.

The patient states at this time that he has not had any pain since the operation and that he was able to resume work in one month from the date of returning home, or six weeks from the date of operation, without any inconvenience.

Comments.—In operating on a considerable number of hernias, it will be noticed that the fascia of the external oblique has thin lines. In some cases it being almost impossible to suture on account of this thinness. In this case the patient probably had at the location of the split a thin area and when a sudden intra-abdominal pressure was exerted, the abdominal wall gave way at its weakest point, which in this case, was the fascia in the lower abdomen, and the giving way of this fascia allowed a bulging forward of the tissues beneath, with a constant spreading effect exerted upon the fascia, which gave the patient a sensation of tearing or weakness when he stood upon



Fracture of tibial sesamoid of the great toe. X-Ray by Dr. Hollis Potter.

his feet or exerted any muscular effort which increased abdominal pressure. The operation is a simple one, of which we have seen a number of cases that have apparently been unrecognized. It is a thing to which attention has not been called by text-book writers.

The reason so much time was allowed to elapse between the first examination and the operation, was the fact that there was a large amount of infection in this patient's mouth and it is deemed inadvisable to make any operation where one expects to leave a clean wound, when there is a possibility of blood-borne infection constantly menacing the wound; and in our opinion every case to be operated should be carefully looked over for infection before any operation is performed, and such an infection eliminated before the operation is made. Otherwise, a large number of cases will suppurate, which otherwise would not; and since we have been following this rule as a standard policy, the infection of clean wounds, even to catgut infections, has been cut down more than 75 per cent.

FRACTURE OF THE TIBIAL SESAMOID OF THE GREAT TOE

N. S., male, age twenty-two years. Occupation, expressman.

On October 21, 1920, a casting fell, striking his right foot over the head of the first metatarsal. He had acute swelling of the great toe and around the heads of the metatarsals, and was disabled for five weeks, his foot being placed in a cast. When he started to walk, he says, he had acute pain under the head of the first metatarsal and ever since then he has been unable to bear any considerable amount of weight on the ball of the great toe. This pain is sharp and stabbing in character when he throws his weight on the ball of the great toe and appears also when the toe is brought into extension passively.

Examination shows a point of tenderness immediately over the internal sesamoid; this mass, which is about the size of a hazel nut, is tender. Palpation of the external or fibular sesamoid does not give pain. The X-ray indicates a fracture of the head of the metatarsal, with a distinct fracture at about the junction of the posterior and middle third of the tibial or internal sesamoid. See Fig. 49. The patient's shoe shows that he is throwing his entire weight on the outside of this foot, the inside of it being held almost off the ground by an inversion of the foot, which position the patient assumes to protect the ball of the great toe. An effort was made to relieve the pain, by a thick pad of felt placed in the longitudinal arch and brought down to just back of the head of the first metatarsal. This gave

some relief, but not sufficient to allow the patient to return to work. This was supplemented by a circular pad of felt cut out hollow in the centre, like a bunion plaster, and surrounding the head of the first metatarsal. While this offered further relief, the patient could not wear a shoe with both these pads in place and they did not make him sufficiently comfortable to return to his occupation. Therefore, it was decided to remove the sesamoids.

To do this, a curved incision was made with the convexity upwards, starting back of the head of the first metatarsal, its highest point being in a line midway between the lateral median line and the dorsal median line of the head of the metatarsal. From this, curving downward to just distal to the head of the first metatarsal. The flap was retracted towards the plantar surface of the foot and the tibial sesamoid exposed, laying in the tendon of the flexor longus hallucis. This was removed by grasping with a sharp tooth forceps and excision with the knife. It was seen that the surface, which came in contact with the plantar surface of the head of the first metatarsal was rough and had been fractured almost straight across. The fibular sesamoid was then retracted out of the wound and removed in the same manner. This appeared to be normal in all respects. The plantar surface of the head of the first metatarsal was examined and no irregularities discovered. The wound was closed. The patient was not allowed to put any weight on the foot for three weeks and during this time, active and passive motions of the toe were instituted to prevent adhesions between the remainder of the flexor longus hallucis and the under surface of the head of the metatarsal. At the end of three weeks, a pad was put in the longitudinal arch with its thick edge just back of the head of the first metatarsal, was placed in the shoe and the patient allowed to resume active use of the foot. He claimed that he had no more sharp pain in the foot, although there was still a soreness at the head of the bone and this continued for some weeks after active use of the foot was resumed. He returned to work about eight weeks following the operation.

Comments.—Fractures of the sesamoids are not uncommon following blows on the head of the metatarsal. The diagnosis is somewhat difficult without the X-ray and, in fact, cannot be positively made without the X-ray and a good radiogram. Care must be taken in making a diagnosis of this kind, inasmuch as some sesamoids are

bipartite and not a few have lines of cleavage which simulate fractures. These lines, of course, are regular and smooth and with a good radiogram can be distinguished from the irregular separation of a fracture line. In the X-ray of this case, the line of fracture may be seen running part way through the bone. The posterior portion of the bone is slightly angulated and overlapping here has obscured the line of fracture. Only the fracture through the internal surface of the foot can be brought out clearly.

SUB-CORACOID DISLOCATION OF THE HUMERUS WITH DETACHMENT OF MUSCLE INSERTION AND BONE IN GREATER TUBEROSITY

R. M., examined February 8, 1921.

On August 16, 1920, while operating a sand blast machine, it became blocked and in straightening it out he got caught either in a shaft or belt. He remembers nothing except finding himself below on the floor, a drop of twelve or fifteen feet; was taken to a hospital where a dislocation which existed in the right shoulder was reduced and some injury to the ribs treated. The arm was bound to the chest wall at the side with the hand against the front of the chest in full adduction and internal rotation.

Since then he has been unable to use the shoulder except in flexion and extension. External rotation is painful and abduction beyond forty-five degrees is impossible. On extension there is seen to exist considerable atrophy of the deltoid and some of the upper muscles of the arm. The arm can be raised laterally to ninety degrees by supporting it at the elbow. This angle cannot be maintained when the support is released, the arm dropping down to the side and the effort to support on the part of the patient giving him sharp pain. There is tenderness over the greater tuberosity and also tenderness in the supraspinal fossa over the area of attachment of the supraspinatus muscle. The X-ray taken at the time of the injury shows a sub-coracoid dislocation of the head of the humerus and also shows, on careful inspection, a fuzzy area which appears in the X-ray at the lower posterior margin of the acromion. This, it will be recognized, is a shell pulled from the supraspinatus and infraspinatus muscles, if not the teres minor. See Figs. 50 and 51.

These injuries have been spoken of in a previous issue, Vol. IV, Series 30, as has also their treatment. This case is given to illustrate the extremely flaky consistency of the detached fragment, and the care with which it must be looked for in all dislocations of the

shoulder. This patient has a serious disability of the arm as a result of two things: The improper treatment of the dislocation by binding it to the side for a considerable length of time and the lack of replacement of the attachment of these two important muscles. Unless a perfect profile of the greater tuberosity of the humerus is obtained in an injury of this sort, the detached fragment might be entirely overlooked and the disability go unaccounted for.

MUSCULO-SPIRAL NERVE INJURY

G. L., male, aged forty years; laborer.

History of Present Condition.—In September, 1920, one month before the first examination, this man received an injury in which a piece of steel entered his left arm just above the external condyle, and at that time there was an artery severed. This was ligated and soon thereafter he noticed he could not raise his wrist.

Examination shows that this man has a left wrist drop. There was loss of sensation over the dorsum of the hand and over the radial side of the thumb. This was a loss of sensation to pin pricks only. There was also inability to extend the fingers and a marked atrophy of the extensor group of muscles. The electrical reactions showed an increase in galvanic irritability and a diminution in the faradic irritability.

Urine examination was negative. Blood showed that Wassermann was negative and had 12,500 whites. The teeth showed marked pyorrhea and four decayed teeth. As there was no other source of infection found, it was believed these teeth were the cause of the increased white blood cell count.

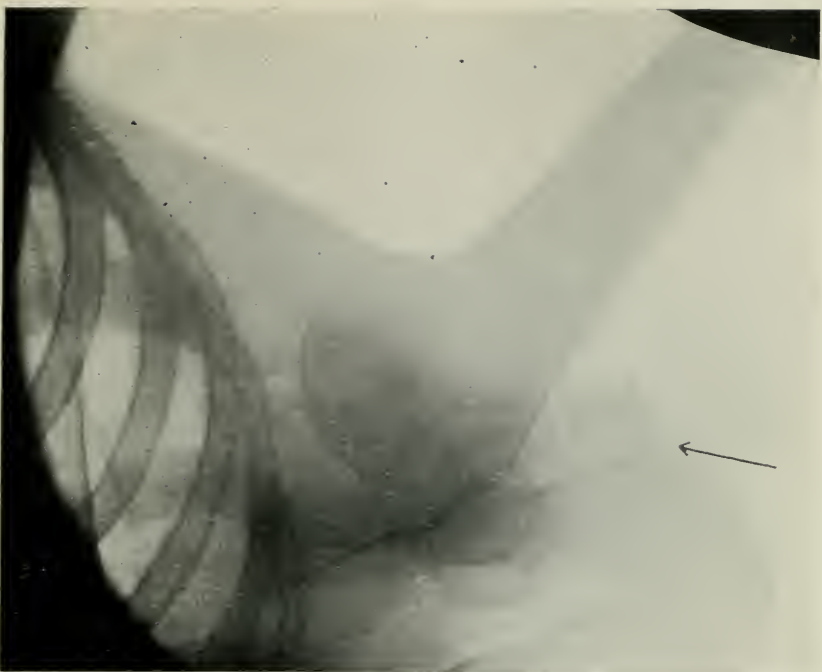
Diagnosis of Nerve Injuries.—In our clinic we use for nerve diagnosis, the methods set forth in the Manual of Neuro Surgery, published by the United States Army during the war. Sensation is tested first and is mapped out as shown in our Clinics in the issue of Vol. IV, Series 30, page 15.

Epicritic sensation is tested by shaving the skin and using a small camel's hair brush. Protopathic sensation is tested by a sharp pin on the end of a six-inch stick.

Deep sensibility is tested by the pressure of a pencil.

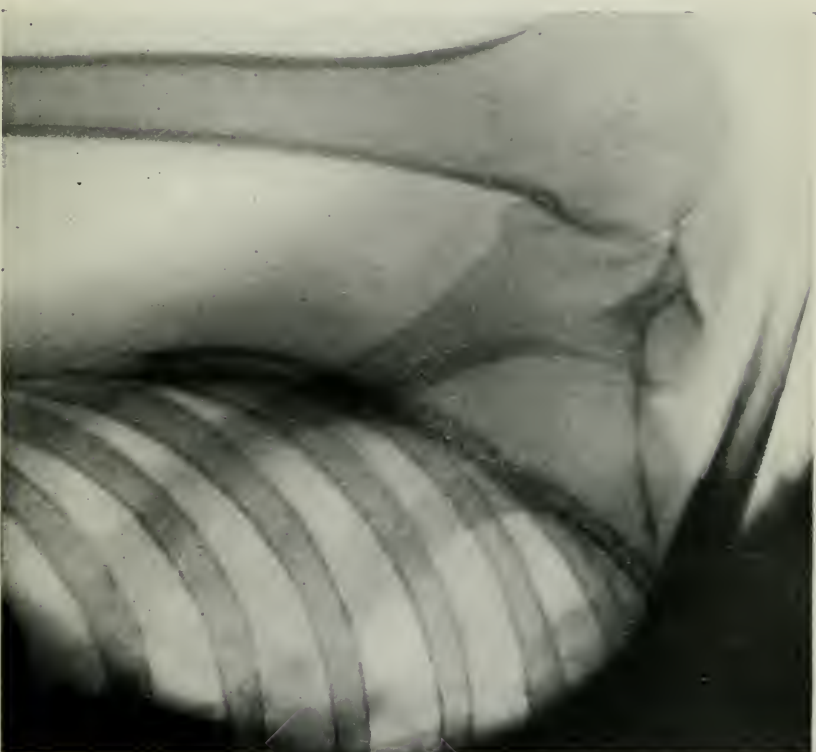
Complete division of a nerve means the loss of all forms of sensation carried by that nerve in a different but definite region for each nerve.

FIG. 50.



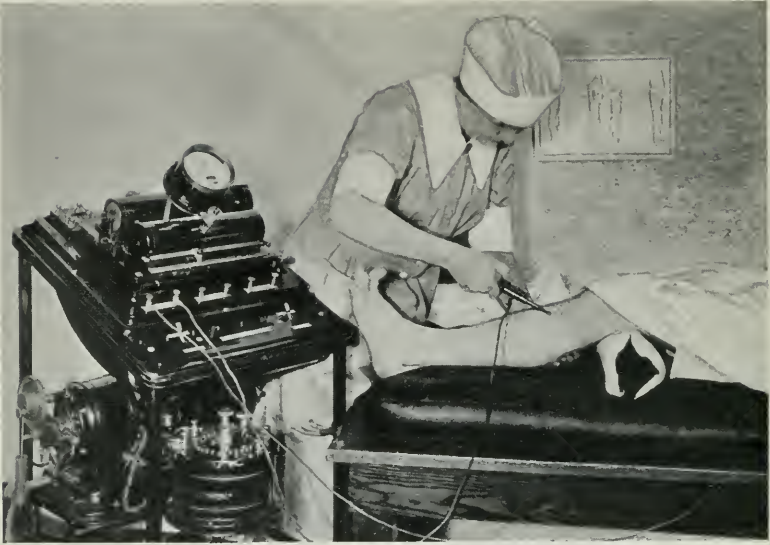
Sub-coracoid dislocation of the humerus before reduction showing detachment of muscle insertions with piece of bone from greater tuberosity.

FIG. 51



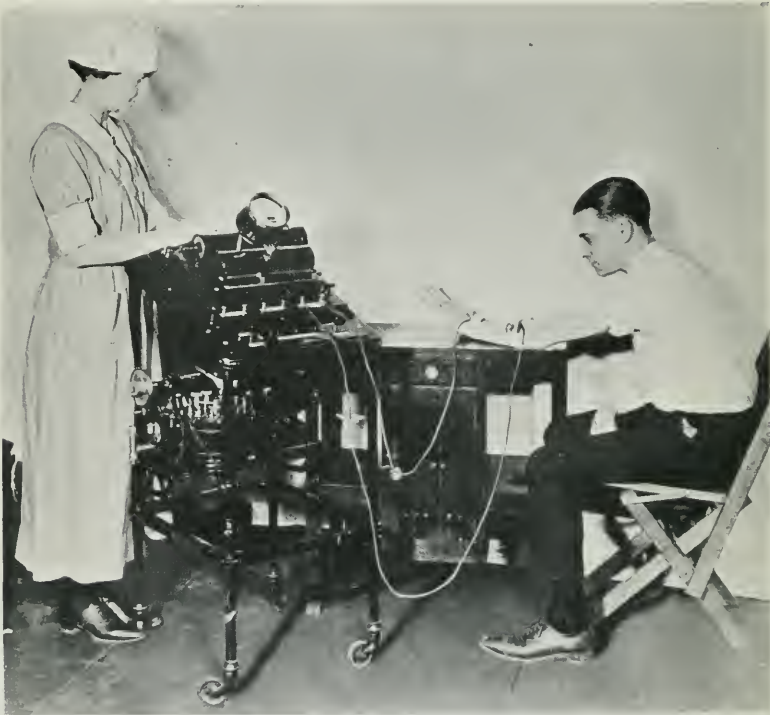
Dislocation of humerus after reduction showing fuzzy area around the head indicating the detachment of a shell of bone with the muscle insertions.

FIG. 52.



Electrical diagnosis of peripheral nerve injuries. The indifferent electrode is over the sternum. Note the interrupter on the handle of the diagnostic electrode.

FIG. 53



Treatment of musculo-spiral nerve lesion with slow sinusoidal current with the Victor Multi-plex Sinusoidal Apparatus.

Motor power is tested by examining the action of each muscle supplied by the particular nerve for the movement, muscle tone, reflexes and atrophy.

Electrical Diagnosis: In our clinic we use for this purpose the Victor Multi-plex Sinusoidal Apparatus, with a diagnostic electrode and a six- by eight-inch discharging indifferent electrode.

The Method: Apply the indifferent electrode, moistened, over the abdomen or back, being sure that it is firmly applied. Apply the diagnostic electrode over the motor point of each muscle to be tested. We use the motor point charts as given in the Manual of Neuro Surgery, which are taken from Mosher's Electro-Diagnosis.

Regulate the current by the current regulator, being careful not to use an excessive amount of current, which will stimulate other adjoining muscles. We have the patient placed on a treatment table in a good light, with the muscles relaxed. The faradic current is first used and if a normal contraction is obtained, it shows at once that the reaction of degeneration is not present. In the diagnostic electrode we use, there is an interrupter on the handle of the electrode and this is used by placing it over the different motor points. See Fig. 52.

If there is diminished faradic irritability, the galvanic current is then used and it is to be noted if the contraction is slower than that of the normal muscle; if it occurs with less strength of current; if the contraction occurs first with the anode and if it is equal or greater than the kathodal contraction.

A normal motor nerve or muscle stimulated by either the faradic or galvanic current, contracts sharply and quickly. With the galvanic current, when the circuit is closed; with the kathode, as the active pole, the response is greater than when the anode is employed. In a destructive lesion of a nerve anywhere in the peripheral motor neuron, the following occurs: For the first day or two if the nerve is not completely divided, there may be some increase in response when stimulated with the faradic or galvanic currents. After a week the muscles show a diminution or loss of irritability when stimulated by faradic current. With the galvanic current, there is a marked increase noticed when the muscle, instead of contracting with a short, quick jerk, does so slowly, more or less tetanic. At the same time the anodal closing contraction increases and finally may be-

come equal to or greater than the kathodal closing contraction. This is known as the reaction of degeneration.

Vasomotor and trophic changes are now noted, that is, the condition of the skin and nails, muscles, joints and bones and the subjective sensory disturbances, such as causalgia.

In this case there was loss of pin prick sensation over the dorsum of the hand on the radial side of the dorsum of the thumb; there was paralysis of all the extensor muscles and loss of muscle tone in these muscles. The electrical reactions showed only a diminution in the faradic irritability and no trophic or sensory disturbances. It was decided that this nerve was an incomplete division.

Treatment.—As paralyzed muscles stretch and the opposing muscles contract, this hand was put up in a cock-up splint and given daily treatments with the slow sinusoidal current, using a Victor Multi-plex Sinusoidal Apparatus, stimulating muscle groups affected. This was preceded by baking and massage, and the electrical stimulation continued for about fifteen minutes. See Fig. 53.

Operation was not undertaken in this case, as there was some general infection, indicated by the white blood cell count of 12,500. This infection was believed to be due to the teeth, but it is a fundamental principle in nerve surgery that all operations must be done in a sterile field and there must be no possibility of infection. It was believed in this case there was a possibility of infection with these teeth, so it was decided to wait and see if this daily electrical stimulation would improve this nerve injury, for if there are progressive signs of nerve regeneration, no surgical procedures should be undertaken.

This man was examined monthly from this date on, and he showed a gradual improvement. In five months he had a return of voluntary wrist extension, but still weak, and he still did not have the power to extend his fingers.

POSTERIOR INTEROSSEOUS NERVE INJURY

J. S., age forty-eight years.

History of Present Condition.—Five weeks before this examination this man got his right forearm caught in a circular saw, which produced a V-shaped laceration on the ulnar side of the forearm about two inches above the wrist. This laceration, according to the X-ray, extended along the extensor side of the forearm, cutting through the ulna. His arm was in a splint with the fingers in full extension.

Examination showed a paralysis of the extensor of the fingers and a complete inability to extend the fingers. He did have ability to extend the wrist. There was no loss of sensation. The extensor communis digitorum and the extensor carpi ulnaris showed a lessened response to the faradic current, but no increase with the galvanic. The joints of the fingers were all so stiff from immobilization, that there was also no flexion in the fingers. From the location of the laceration it was thought that there was some lesion of the ulnar nerve, but this was tested out and it was found to be intact.

Diagnosis.—The terminal branches of the musculospiral nerve are the posterior interosseous and the radial. The radial is a purely sensory nerve and the posterior interosseous is a motor nerve which supplies all the extensors except the extensor carpi radialis longior.

In this case the diagnosis was made from the above findings, that there was a lesion of the posterior interosseous nerve because there was no wrist drop, but there was paralysis of the extensors of the fingers and the ulnar extensor of the wrist. There was also no loss of sensation. This case is given to show the difference in lesions of the musculospiral and its branch of the posterior interosseous. The treatment given was practically the same as in the preceding case.

JOINT PAIN FROM FAULTY WEIGHT-BEARING LINE FOLLOWING FRACTURE OF BOTH BONES OF LEG

G. B., aged fifty-two years, examined March 31, 1921.

Six months ago this patient sustained a fracture of both bones of the left leg at the junction of the upper middle third, which was treated by application of a plaster cast. He has been bearing weight on the leg for approximately three months.

There is little or no swelling and he complains of no pain at the site of fracture. He does, however, complain of a great deal of pain and some swelling, especially upon use, occurring in the knee and ankle, but mainly in the knee. There is also some pain in the arch of the foot. With the patient's legs bared and standing, one has immediately the impression of a severe case of knock-knee, but comparing the injured leg with the opposite one, it is seen that the legs are normal down to the junction of the upper and middle third of the bones of the left leg. See Fig. 54. When an acute outward angulation takes place and while the knees are together, the feet are some four inches apart.

The thing that he complains of bitterly now is pain on the inside of the knee. He locates it at the internal lateral ligament and the reason for this pain is very evident. His weight-bearing line on the left side is entirely distorted on account of the acute angulation which throws his weight at every step on the internal lateral ligament, and the arch of the foot and ankle-joint. The X-ray shows enough callus to bear the weight and this accounts for his lack of pain at the site of fracture. The swelling in the knee is easily accounted for by the overstrain, which is exerted on the ligaments pulling this joint, and this will get worse rather than better as time goes on. The pain in the ankle and arch of the foot are accounted for on the same basis. Instead of the weight falling from the anterior superior spine through the middle of the patella into the middle toe, the weight line falls from the anterior superior spine through the middle of the patella and fully four inches towards the right, from the ball of the left foot, throwing a very severe cross strain on the instep, ankle and knee, which the ligaments supporting these joints are not able to bear, and as the patient walks or bears weight these joints give way in their ligamentous supports and cause traumatic inflammation, which in turn causes an exudate and swelling. This inflammatory process and pain will continue as long as the strain continues, which will be for the remainder of this patient's life unless something is done to correct the angle.

Comments.—One may have an overlapping of fragments in a fracture without having any considerable change in the weight-bearing line and there may be a considerable shortening without seriously disabling the individual if the weight-bearing line is properly watched. It is the angulation of fragments, so that a cross section is thrown on the joints or bones which are unable to support this strain that gives pain, and angulation in any direction is a serious disability following a bone or joint injury.

FRACTURE OF THE LEFT PUBIS AND RIGHT ILIUM AT THE SACRO-ILIAC JOINT

I. K., age thirty-eight years. Occupation, motor mechanic.

History of Present Condition.—Eight months ago this man was aiding to move a five ton truck with one end set on jacks. This end slipped and the entire weight fell on the left lower abdomen of this man.

FIG. 54.



Joint pain from faulty weight bearing line after fracture of both bones of legs.

FIG. 55.



Fracture of the left pubis and right ilium through the sacroiliac joint.

FIG. 56.



Fracture of the sacrum and coccyx. Note the difference in the right and left halves of the sacrum and coccyx, the left half is fractured with the fragments displaced upward and inward. X-Ray by Dr. Hollis Potter.

Examination.—He was sent at once to Wesley Hospital, where examination showed that he was conscious, with a strained facial expression and unable to urinate. There was a large, soft swelling over the left inguinal region, superficial to Poupart's ligament. A catheter was passed without any apparent difficulty and several ounces of urine obtained. Rectal and prostatic examinations were negative. He had abrasions over both knees and a laceration on the outer side of the right thigh, about one and one-half inches long. He complained of pain in two places: one, over the left inguinal region and two, in the region of the right sacro-iliac joint and down the back of the right leg.

His urine showed microscopic red blood cells for several days after admission, but he was able to urinate normally after the first catheterization.

X-ray showed a fracture of the left ascending and descending rami of the pubis and what was then diagnosed as a slight displacement of the sacro-iliac joint. Diagnosis was made of fracture of the left pubis in two places and a right sacro-iliac displacement. He was kept in bed for eight weeks with a strong pelvic binder and a Buck's extension to his left leg. He did not return to work and after his departure from the hospital did not come back for reëxamination until some months later.

Several months after his injury, an X-ray was taken as is shown in Fig. 55. This showed there had been a fracture of the ilium at the right sacro-iliac joint and there was now a marked callus formation in this region. The man complained of absolutely no pain from this fracture and the pain in the right leg had cleared up. He did complain of pain down the inner side of the left leg. He also had a considerable loss of power of abduction of his left leg. This pain and loss of power was due to pressure by the callus on the obturator nerve as it made its exit from the pelvis through the obturator foramen.

Comments.—Piersol in his *Anatomy* (Lippincott) says: "If the traumatism has been a crush in the antero-posterior direction, the pubis will probably first fracture; if the force is continued, the protection afforded by the arch having been withdrawn, the pressure comes upon the main arches, which tend to open out. A portion of one of these arches may then give way and a second fracture may occur through the ilium into the sacro-iliac notch, or vertically

through the sacrum itself. More commonly, however, the anterior sacro sciatic ligaments give way and a certain amount of disjunction of that joint occurs. Even if the crushing force is applied laterally, it is usual to find the pubis again fractured from indirect violence. If the application of the force is continued, the strain comes upon the posterior sacro-iliac ligaments which may rupture, but are more likely to withstand the violence, which then may result in the tearing away of a portion of the bone into which the ligament is inserted."

The above explains this injury fully. The man now has no pain in his sacro-iliac joint or in the nerves near this joint, as there is firm callus formation here preventing any motion. The pain in the left leg is due to the pressure of the callus from the fractures of the rami of the pubis on the obturator nerve.

FRACTURE OF THE SACRUM AND COCCYX

C. S., age thirty years. Occupation, chauffeur.

History of Present Condition.—Seven months ago this man was driving a small truck when he had a collision with a taxicab and he was thrown out, landing on a curbstone. He was taken, unconscious, to a hospital, where he remained for a month, with a diagnosis of fractured pelvis.

Examination six weeks after injury showed an extremely well-developed colored man; all reflexes normal; no glandular enlargement. Teeth, tonsils and throat negative. Heart and lungs and abdomen negative. All extremities showed normal motion and strength. All motions were normal and there were no points of tenderness. Pressure over the sacrum and coccyx caused extreme tenderness. This pain he says is constant and is in the region of the sacrum and on the inner side of the left leg. Unless his bowels were very loose, bowel movement caused excruciating pain.

X-ray taken by Dr. Hollis E. Potter includes the lower lumbar spine and entire pelvis. There is no evidence of fracture in any of the structures of the spine or main bony ring of the pelvis. There is a pronounced difference in the right and left half of the lower sacrum, in that the left half is fractured with the fragments displaced upward and there also appears a slight comminution of the left side of the coccyx. The ilii, sacrum and pubis are negative, See Fig. 56.

Comments.—Fracture of the sacrum and coccyx by direct violence are said to be extremely rare. The sacral plexus here was not injured and there has been no paralysis. It is to be noted in this case that

he has more pain some months after his injury than he did after he got up and first started to walk. From the X-ray it would seem that the callus formation would cause him considerable pain by pressing on the sacral nerves, and he has pain over the distribution of these nerves.

He claims to have such pain at times, that the condition of coccygodynia must be considered, although this condition is usually not seen except in women; and is usually caused by something else than a fracture of the sacrum. There is no indication, on physical examination, of a cause for such severe pain as this man claims to have at times, as there is tenderness over the sacrum, but it is not severe.

Treatment: There are no indications for operation for removal of any bone, as the X-ray shows that the fragments are jammed together, and any operation would be so extensive that it would injure most of the sacral nerves on that side, and do more harm than good.

FRACTURE DISLOCATION OF THE FIFTH CERVICAL VERTEBRA

J. F., aged fifty-four years; laborer.

History of Present Condition.—This man states that one year ago he was working in an ice house when the whole ice house collapsed, and he has no knowledge of what happened thereafter, but learned later that he was unconscious for four days, in a county hospital, and had at that time severe pain in his neck and back. He gives his age as fifty-four years, but looks many years older.

Present Complaint.—He complains now of continuous pain in the lower cervical and upper dorsal spine. This pain has showed no increase or any diminution in the last six months. He says he has lost about 20 pounds in weight and all motions of his neck causes an increase of this pain.

Physical Examination.—Pupillary reflexes are normal. All the teeth are in dreadful condition and there is marked pyorrhea. Tonsils and throat are negative.

The cervical spine shows in the region of the sixth cervical vertebra, a marked thickening, and the spinous process of this vertebra is considerably more prominent than normal; and the fifth cervical is less prominent than normal. In this region the cervical spine is absolutely rigid and there is considerable limitation of motion. Forward flexion of the head on the spine is painful. Lateral

motion is greatly limited and painful. Complete extension of the cervical spine is impossible. There is marked tenderness in the upper dorsal vertebræ. There is no tenderness in the lumbar spine and motions in the lumbar spine are practically normal.

The lungs are negative. Heart shows marked weakness of the muscular sound, but no murmurs. The extremities, all reflexes and motions are normal. Complains that it causes him considerable pain on abduction of both arms to an angle of beyond ninety degrees, although this motion is normal to its fullest extent.

X-ray by Dr. Hollis E. Potter shows a most pronounced sort of hypertrophic arthritis in the cervical and dorsal spine; between the fifth and sixth cervical vertebræ there is a disalignment in which the upper vertebræ are displaced forward on the lower segment at least one-quarter of an inch. There is some callus formation about this, indicating a slight fracture along with the displacement. Back of the sixth and just above the tip of its spinous process is a small opaque island, which is probably a calcified gland in the posterior triangle. See Figs. 57 and 58.

Diagnosis.—This case was in considerable dispute and a number of antero-posterior X-rays had been taken and no diagnosis except an arthritis had been made; before the examination in our clinic, there had been no lateral X-ray made. With the examination which showed a displacement and the lateral X-ray as shown in Fig. 57, there can be no doubt of the diagnosis of fracture dislocation between the fifth and sixth cervical vertebræ.

Treatment.—At this time there is practically no treatment that will relieve the major part of this man's symptoms. His lesion was not recognized at the time of his injury. If it had been, he should have been placed in bed with extension from his chin and occiput to the head of the bed, and should have been kept in this position for at least three months. As he is now, the deformity is permanent, as there is callus formation and the disability is likewise permanent and totally disabling him from his work, as every motion of his neck causes him pain.

In this case it is to be noted, that in spite of this marked displacement, as can be seen in a lateral X-ray view, there was not at any time any lesion or even a peripheral nerve lesion. And even now, he has no pain running down the nerves of his brachial plexus and only has pain on motion of his cervical spine.

FIG. 57.



Fracture dislocation of the fifth cervical vertebræ. X-Ray by Dr. Hollis Potter showing anterior fracture dislocation of the fifth on the sixth cervical.

FIG. 58.



Antero-posterior view of fracture dislocation of the fifth cervical vertebræ. X-Ray by Dr. Hollis Potter.

THE HOSPITAL FUND OF THE U. S. RECLAMATION SERVICE

By HUGH ARBUTHNOT BROWN, M.D.

U. S. Reclamation Service, Washington, D. C.

THE United States Reclamation Service, the home-making bureau of the Department of the Interior, in its work of constructing dams and irrigation systems to impound the life-giving water and carry it through thousands of miles of canals and laterals for the irrigation of otherwise arid and semi-arid land in our Western States, very early found it necessary to provide means of caring for the health of its field employees.

Construction work was frequently carried on in remote and more or less inaccessible regions of the country, practically on the fringes of civilization, many miles distant from any town, and consequently not within easy access of physicians or hospitals. In these remote places construction camps were established, varying in size from 200 to 1000 or more persons, and here men labored, suffered the usual ills to which flesh is heir, and were subject to accidents incident to the more or less hazardous nature of their work.

Of necessity therefore these means of safeguarding the health of its employees were supplied by the Service through the construction of small hospitals at the site of the work, in charge of a physician employed either as a result of a Civil Service examination or by contract. In either case deductions of \$1 per month from the pay of each employee were made to cover the cost of this service, the money so collected forming on each project a so-called hospital fund.

In the case of a Civil Service physician, he was paid a specified salary by the Service and was furnished a small hospital, usually consisting of an office, waiting room, operating room and ward with from four to six beds; and his necessary instruments, supplies, and drugs. In the case of a contract physician, he received a certain percentage of the amount collected each month from the employees for the hospital fund, depending on the amount bid in his contract (*e.g.*, 80 cents per employee), and himself furnished supplies, drugs, and in some instances hospital facilities. There were more or less minor

variations from these methods, but in general they were as outlined above.

As a rule these two methods worked with satisfaction, although it was felt that better results were obtained from the employment of Civil Service physicians than from men under contract; and wherever possible to obtain qualified physicians under the Civil Service rules they were employed in preference to the contract men. In general the Civil Service physician lived on the work and devoted his entire attention to the men in the construction camps; whereas the contract physician frequently lived in a town many miles from the work and made only weekly or semi-weekly visits to the camps, where first-aid outfits were installed, unless called for some special purpose. In some instances also the contract physician would sub-let his contract, which did not always prove a satisfactory arrangement.

Later, wherever practicable, which was usually the case as soon as a portion of a project was placed upon an operation and maintenance basis, following construction, and settlers had taken up the lands, with the coincident building up of adjacent towns, it became the policy of the Service to do away with both Civil Service and contract physicians and utilize the services of local physicians. One reason for doing so, aside from those mentioned, was that this action tended to produce better relations between the Service and these local and frequently influential men in nearby communities. Naturally, where Civil Service or contract physicians were employed by the Service, performing all the work of attending to the health of a large body of employees and receiving the entire remuneration for such services, the local physicians felt that they were being discriminated against and that such work should logically fall to them as members of the community in which the project was located.

Carefully safeguarded in order to prevent abuse, both on the part of the employees and of the physicians, this plan has proved entirely satisfactory and is in operation on all of the twenty-four strictly Reclamation Service projects (excluding the Salt River project, Arizona, which has been turned over to and is being operated by the water users) and the three Indian projects (under construction by the Reclamation Service), whose location is indicated on the accompanying map.

The present arrangement provides for medical, surgical, and hospital treatment of field employees in all cases of sickness except chronic

or venereal diseases or those resulting from alcoholism, and for the treatment of injuries, whether received on the work or not, except such



Principal irrigation projects constructed, or under construction, by the U. S. Reclamation Service.

as are the result of neglect, misconduct or alcoholism, and such as do not come within the provisions of the Employees' Compensation Act of September 7, 1916, which, in general, covers only accidents received on the work. In view of the danger of abuse and the practical im-

possibility of proper discrimination, treatment does not extend to dental work nor to the examination for or the fitting of glasses or the furnishing of glasses, except in case of accidents not covered by the Compensation Act.

In order to provide funds sufficient to cover the cost of treatment, deduction is now made from the pay of field employees at the rate of \$1.50 per month, as follows: A minimum deduction of 30 cents, and after five days 6 cents per calendar day up to the monthly rate. As the high cost of living affected the fees of physicians and the rates in hospitals as well as other elements of the body politic, it was found necessary to meet their advances by increasing the monthly deduction from \$1 to \$1.50, effective May 1, 1920. It is also provided that if at any time during the month an employee receives medical, surgical, or hospital service from the United States, deduction shall be made at the prevailing rate of \$1.50 for one full month. Service is limited to one year.

The usual order of procedure in the case of a sick employee is to secure from the chief clerk or other responsible official on the project an "authority for treatment." This is a blank form, addressed to the physician selected by the employee and stating that the bearer (who is named) is entitled to either medical, surgical, or hospital attention, as the case may be, at the expense of the Government during his present disability, providing his case comes within the regulations of the Service. On the back of the form appear the following brief instructions:

1. Each employee paying a hospital fee and desiring medical, surgical, or hospital attention should be furnished with one of these forms, to be presented to the physician before treatment begins.

2. The Government will not pay the cost of treatment of chronic or venereal diseases, or of injuries received on the work which are the result of alcoholism.

3. No encouragement should be given to employees to call a physician to treat trivial ailments, simply because they have paid a hospital fee.

4. Physicians are requested and expected to coöperate with the Service in limiting treatment to those who are legitimately entitled to it.

At the bottom of the form is a space which the attending physician is requested to fill in and then to return the form to the project office.

In this space the physician is requested to write the name of the disease or the character of the accident; the number of days the patient was under treatment, giving dates; the number of calls made by the physician; the amount of his bill; and such remarks as he may consider it desirable to make concerning the severity of the case, unusual number of calls made, etc.

A large degree of latitude is given employees in the choice of physicians. The project managers secure written statements from all local physicians who are willing to do so, covering such items as a flat rate for office calls, writing prescriptions, a day and night rate per mile for visiting employees living at a distance from the physician's office, and a flat rate for examination of laborers before their employment. Flat rates are also secured from the nearest local hospitals. It is the policy that, other things being equal, the Service should, as in the purchase of any other service or commodity, take advantage of the lowest rates offered by reputable physicians. In other words, in localities where there is a fixed scale of charges by all reputable physicians, the employees are given free choice of physicians. In localities where the charges of certain physicians are much higher than those of others whose services would be entirely satisfactory, the choice is limited to the latter.

As noted on the "authority for treatment" form, it is not expected that an employee will call a physician to treat a trivial ailment simply because he has paid a hospital fee. In case of trivial ailments, which would ordinarily receive home treatment by an employee, an order may be given on a local drug store for simple remedies without first securing a prescription from a physician. Steps are taken by the project managers to safeguard this practice to prevent harm or abuse.

As might be expected on large construction work of the type involved in the construction, for example, of the 349-foot high Arrowrock Dam on the Boise River, Idaho, serious accidents occasionally occur resulting in mangled extremities which necessitate amputation. Employees who are so injured as to lose one or more limbs may, if they so desire, be supplied with an artificial limb or limbs at a cost not to exceed \$250 per limb, such cost to be inclusive of transportation and other necessary expenses incidental to securing a proper fit. This service is limited in that the Government does not renew the artificial limb when it is worn out. Similarly, an artificial eye will be supplied to an injured employee at a cost not to exceed \$15. It

should also be stated that the above service applies only to those cases which do not come within the provisions of the Employees' Compensation Act. In case of the death of an employee who has no known relatives, or if such relatives or the county officials refuse to take charge of the remains and pay burial expenses, the hospital fund bears the expenses of burial in the locality, including the cost of the burial lot, embalming, casket, and all other actual and necessary expenses incident to local burial, limited to a total sum of \$200. Trusses are furnished for slight cases of hernia where the employee does not feel the need of a radical operation.

In order to eliminate as much as possible epidemics of typhoid fever, all employees are urged to be inoculated with typhoid prophylactic. Since July, 1912, this prophylactic has been furnished by the War Department at a cost of 12½ cents per treatment, and over 4000 treatments have been sent to the field. This treatment is free to employees paying a hospital fee, and members of families of employees living in the vicinity of the work may also be inoculated at a cost of 12½ cents for the complete treatment.

It is the general rule of the Service to give the sick or injured employee the benefit of the doubt if there is any question whether his case comes strictly within the provisions of the plan of hospital deductions. It was felt, for example, that an employee paying hospital fees should receive the benefit of the plan even though his injury had not been received in the course of his Governmental duty. As a result an employee has been taken care of for weeks, at no expense to him, because of a broken leg resulting from catching his spikes in the bag while sliding to second base; a married employee, paying hospital fees, has had all the expenses of child birth paid by the Government; an employee who slipped on a rock while hunting and blew off most of the calf of one leg has had all his expenses of treatment paid from the fund. These are but a few examples of the benefit the fund has proved to hundreds of employees who might otherwise have had to depend upon the charity either of some physician or their friends.

Each month the project manager prepares a cost report of hospital fund operations, showing the cost for the month and during the calendar year to date. The following report for the Fort Laramie unit of the North Platte project, Nebraska-Wyoming, for the month of December, 1920, may be taken as typical:

THE HOSPITAL FUND OF THE U. S. RECLAMATION SERVICE 201

This shows that during the month the cost of service amounted to \$65.18, whereas there was collected from the 240 employees paying

DEPARTMENT OF THE INTERIOR
UNITED STATES RECLAMATION SERVICE

7-1041. (Rev. 1917.)
REIMBURSABLE
Cost Report

North Platte PROJECT.

Month of December 1929

Phys. Feat. No. Fort Laramie DISTRICT UNIT.

Class No. 241 Hospital Operation

Authority No.

Detail Acct. No.	ITEMS OF COST.	COST.		UNIT COST.		
		This month.	Calendar Year	This month.	Previous	Cal. to date.
01	Salaries, physicians					
02	" nurses, assistants					
03	Transportation of patients	\$6.36	\$25.53			
04	Medical and surgical supplies	36.82	258.28			
05	Burial expense					
06	Services, other physicians	7.75	821.93			
07	Treatment, outside hospitals	14.25	460.21			
08	Sustenance of patients		345.78			
09						
10						
11						
12						
13						
14						
15						
37	Rent, light, fuel, water					
38	Minor equipment repairs and supplies					
39	Minor miscellaneous expense					
43	Plant charge					
44	Equipment charge					
46	Camp maintenance					
47	Superintendence and accounts					
49	General expense					
	Total cost	65.18	1,911.63	\$0.27	\$0.64	\$0.78
50	Credits	300.24	2,603.37			
	Net gain	235.06	691.74			
		QUANTITY.	QUANTITY.			
	Number of employees paying fee	240	2,440			
	Number of employees received hospital treatment	0	25			
	Received dispensary treatment	30	130			
	NOTE.—Give units for totals only.					

Remarks: (State general health conditions, etc.)

Approved: _____ Prepared by _____

Cost Keeper.

a hospital fee the sum of \$300.24, leaving a balance in favor of the fund of \$235.06. It also shows that for the month of December the unit cost of hospital operations per employee paying hospital fees amounted to 27 cents for each of the 240 employees paying a fee.

The unit cost for the preceding month amounted to 84 cents and for the calendar year to 78 cents per month.

Prior to the epidemic of influenza in the fall of 1918, the hospital account as a whole had shown a consistent gain with deductions from the pay of the field employees at the rate of \$1 per month, as follows: A minimum deduction of 25 cents, and after five days 5 cents per calendar day up to the monthly rate. A few projects, as a result of a number of serious operations or severe sickness, showed a loss, but this loss was more than made up on other projects, so that the fund taken as a whole showed a favorable balance at the end of each year, amounting in recent years to as much as \$25,000 or more. The strain on the fund, however, occasioned by the epidemic of influenza, resulted in a favorable balance of nearly \$31,000 on June 30, 1918, being reduced to about \$17,000 on August 31, 1919, a net loss during this period of nearly \$14,000. During the calendar year 1919, some 4250 employees paid hospital fees amounting to approximately \$40,000. The cost of treatment of these employees, however, amounted to over \$57,000, resulting in a net loss during the year of about \$17,000, although the fund as a whole still showed a net gain from the beginning of operations to December 31, 1919, of nearly \$12,000.

As the services of physicians and hospitals had been furnished to the employees during 1919 at a unit cost per employee of \$1.13 per month, whereas the deductions were only at the rate of \$1 per month (which, in view of the large turnover of labor really amounted to an average of less than 90 cents per employee per month), it was decided that the rate should be increased to \$1.50 as above mentioned. This decision was also influenced by the fact that the rates for services of physicians and hospitals had taken a decidedly upward swing in line with the nation-wide price inflation. It is believed that this new rate, which went into effect in the spring of 1920 will be ample to cover the cost of treatment of the field employees of the Service, and it is quite possible that later a return to the old rate of \$1 per month may safely be made, as it is desired that the hospital fund show only a reasonable margin of safety for the protection of its beneficiaries. That this belief is justified is indicated by the fact that on December 31, 1920, the fund as a whole showed a favorable balance of over \$25,000, a net gain of about \$13,000 during the year, and that practically every project whose hospital operations showed a net loss during the year 1919 showed a net gain during 1920.

Surgery

THE SURGICAL KIDNEY. A SYSTEMATIC METHOD FOR DETERMINING THE DIAGNOSIS AND MODUS OPERANDI

By G. S. FOSTER, M.D.,

Surgeon

and S. MILLER, M.D.

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WHEN is the pathological or other kidney surgical and when is it not? To answer this question, one must exhaust every means of scientific research and investigation. This is, however, not a difficult problem if studied in a systematic manner.

There are many pathological kidney conditions which require, even demand, surgical interference, but all kidney conditions are not to be considered surgical.

For several years we have treated the question of operable kidneys in a very conservative manner, for we have not felt that any kidney should become surgical until all other means have proven ineffective or until a clear, definite and differential diagnosis has been made.

We have carefully tabulated each kidney case that has come under our observation and the conclusions reached have very naturally eliminated all unconsidered action and have caused careful method of simple diagnosis and differential diagnosis.

In reviewing these cases and the methods used, the following tabulation will very clearly show the simplicity of the procedure. Although it has taken much time and effort, the results reached and conclusions drawn are after all very simple, as are all things that seem complicated at first. The various kidney conditions will be taken up in their regular order.

1. NEPHRITIS:

(a) Intertitial.

(b) Parenchymatous.

2. DISPLACED KIDNEY (NEPHROPTOSIS):
 - (a) Traumatic.
 - (b) From sudden, extreme loss of weight.
 - (c) Congenital (Malplaced and supernumerary kidneys).
 - (d) Occupational or form of dress.
3. NEPHROLITHIASIS:
4. TUBERCULOSIS:
5. SEPTIC INFECTION:
 - (a) Acute.
 - (1) Primary.
 - (2) Secondary.
 - (b) Chronic cold abscess.
 - (1) Short duration as to signs or symptoms.
 - (2) Long duration as to signs or symptoms.
6. TRAUMATIC:
 - (a) Rupture.
 - (b) Ecchymosis.
 - (c) Hemorrhagic:
 - (1) Controlable.
 - (2) Noncontrolable by ordinary methods.
 - (d) Markedly displaced.
 - (1) With hæmaturia.
 - (2) Without hæmaturia.
 - (3) With physical signs and symptoms subjective and objective.
 - (4) Without physical signs and symptoms subjective or objective.
7. NON MALIGNANT GROWTHS:
 - (a) Involving the kidney parenchyma.
 - (b) Extra capsular.
8. MALIGNANT GROWTHS:
 - (a) Involving the kidney parenchyma.
 - (b) Extra capsular.
9. ACCUMULATION OF SECRETION:
 - (a) Obstruction in urethra.
 - (b) Unilocular cyst formation.
 - (c) Multilocular cyst formation.
 - (d) Obstruction within pelvis.
10. HEMORRHAGE WITHIN KIDNEY CAPSULE:
 - (a) Severe and distending (acutely).
 - (b) Gradual and persisting.
11. PHLEBECTASIS:
 - (a) Beneath capsule.
 - (b) Interstitial.

We have used the above classification in both simple and differential diagnosis with comparatively good results. In making a differential diagnosis we have also used the following table effectively:

1. Complete history.
2. Thorough physical examination.

3. Complete laboratory investigation.
4. Cystoscopy and catheterization of ureters. (Differentiation of individual kidney function.)
5. Röntgenogram with and without catheters *in situ*.
6. Injury of kidney, pelvis and X-ray.
7. Observation for one week, daily investigation, except in emergencies.
8. Ample period for recovery from shock or collapse in acutely precipitated cases.
9. Individual checking up of classification and by ruling out, determining the one or more probabilities.
10. Recommendation of surgical interference if warranted. If not surgical, referred to internist with recommendation of monthly return at his discretion for complete reinvestigation.
11. Individual function determination for each kidney.
12. Summary of end results.

When the various kidney conditions have been taken up and separated into their classes, a rather definite diagnosis is generally reached. Following this diagnosis, the procedure, in so far as surgical interference is concerned, depends on one or both of two facts, namely:

The affected kidney is found to be in a stage of apathy or non-functioning; or the affected kidney is ready to contaminate, or has already contaminated, adjacent or distant structures.

Again, whether or not nephrectomy shall be performed or a more conservative treatment instituted is determined at the time of operation by the macroscopical appearance of the kidney itself and the condition of the surrounding structures. We believe that no kidney should be sacrificed if there is any hope that it can later function up to 35 per cent. without liability of metastatic influence on other structures. Of course, it goes without saying, that it is absolutely certain that the patient has two kidneys and that the percentage of functioning ability of each is known.

SEPARATE CONSIDERATION UNDER THE CLASSIFICATION

1. *Nephritis*: (a) *Interstitial*; (b) *Parenchymatous*.—Decapsulation in these conditions has never proven a wise procedure in view of the end results of our cases. We do not therefore consider this condition a surgical entity and refer these cases to the internist for his care and judgment. If co-existing conditions in or about the kidney are present, an endeavor is always made to rule these out. Not infrequently have we seen an apparently clearly cut nephritis

have an accompanying malignancy or benign growth which warranted surgical interference.

2. *Displaced Kidney (Nephroptosis)*.—The average textbook will draw attention to the frequency of occurrence of this condition in women as compared to men. Eisendrath states that "85 per cent. of movable kidneys occur in women." Caille states that "floating kidney is rather common in women." Contrary to these findings regarding the movable or the floating kidney our findings vary from the past percentage.

In summing up the findings on physical examinations of one hundred cases, 50 males and 50 females, taken as they come without regard to the ailments, our findings were as follows: In eight of the males the kidney was found below the costal margin, and between that point and the brim of the pelvis, or in the pelvis. Thus 16 per cent. of the males in this group had a displaced kidney, a much higher percentage than the textbooks give. Of these eight cases five were of the right and three the left kidney. This shows a 10 per cent. right-sided and 6 per cent. left-sided involvement. In the females, twelve displaced kidneys were found. The mobility of these kidneys varied in the space between the costal margins and the brim of the pelvis or at times were found in the pelvis. Bimanual pressure was exerted during free respiratory excursion in all cases. This shows 24 per cent. of displaced kidneys in the female. Of these twelve cases, eight occurred on the right and four on the left side, showing a 16 per cent. right and 8 per cent. left kidney displacement.

The conclusions drawn from this series of cases bring the percentage of the sexes very much nearer each other than our textbooks state. We believe that if care is taken in making physical examinations, males would show a higher percentage of displaced kidneys than the summary of past findings indicate.

Possibly the modern athletic activity of men will account for this. Again, the laxity of detail in making physical examinations or the adoption of old statistics as accepted facts, may account for it. It might be fair to state that in only three of these cases was complaint made of the kidney, as the fact that a movable kidney did exist was not known to the patients. However, we do believe that a larger per cent. of movable kidneys will be found in males if care be taken in making the physical examination.

We place displaced kidneys in two classes, as did Bennie: movable kidney and floating kidneys. Of course, it is quite impossible to differentiate which exists by physical examination alone. When operable, the technic of surgical treatment varies somewhat. This is especially true in approaching the kidney, delivering the kidney and anchoring the kidney.

The floating kidney is one entirely surrounded by peritoneum which has taken an abnormal permanent position. On the other hand, the movable kidney is covered by the usual amount of peritoneal investment and is truly more or less temporarily displaced, but still holds the relative amount of normal peritoneal covering. In other words, the floating kidney is congenital and the movable kidney may be acquired. Our findings show no standardization of this fact as regards sex.

Operative Selection.—When considering displaced kidneys from an operative point of view we decide whether it is best to operate entirely upon the symptoms elicited by the displaced organ, the acuteness of the condition (that is the length of history directly involving the kidney), the surgical risk to the patient, and the general physical condition.

(a) *Traumatically Displaced Kidney.*—If we recognize that the most frequent cause of a displaced kidney which gives direct symptoms of altered positions is traumatism, we will consider this condition first.

Here we have a condition very acute in origin and generally profound in its symptoms and signs. Possibly other conditions, pathological in nature have arisen, such as fractures, involvement of other organs, extreme fright and psychical attitude, or even a profound shock.

If the patient is in any wise in extremis, we give complete rest under induced composure and whatever supporting measures are indicated, and then await results, for we deem an expectant procedure wise in such cases.

During this period of rest a thorough laboratory investigation is made, which is instituted in every instance, whether the condition be acute or chronic, traumatic or otherwise. We very carefully observe the kidney function, presence or absence of hæmaturia, nitrogen output, uric acid, urates and urea excreted, the twenty-four-hour total, and also more closely the specific gravity. Along with that, the blood

observations, urinalysis, coagulability time, blood-pressure, Wasserman test are all entered into carefully.

We believe that all traumatically displaced kidneys call for operative procedure sooner or later. If it be an uncomplicated case, that is, one without cocompitant injuries, we permit rest from three to seven days in order to overcome the reactionary hemorrhagic status and, then proceed without further delay to avoid the complication of adhesions about the kidney capsule.

(b) *Displaced Kidney in Patients Having Sudden Loss of Weight.*—Here we are dealing with complications as a rule. We may find a patient who complains with abdominal trouble and has observed that the weight has dropped materially during a stated period. On making the physical examination we find a markedly displaced kidney.

However, other things may show themselves, such as marked anæmia, a tumefaction somewhere, some nerve involvement, etc. All of these things must be carefully considered. In the average instance the primary cause of loss of weight should be discovered. We cannot place this at the door of a displaced kidney which seems otherwise normal, especially in a patient who complains of other things and has never placed his area of symptoms within kidney range. If some tumefaction is found and it is decided as operable, we must concentrate our efforts on this part. If it be a primary anæmia, we must pay our respects to this. If the anæmia be secondary, its cause must be treated, and so on. In other words, we believe the cause for loss in weight must be cared for, and the displaced kidney not seriously considered. If surgical, the part most presenting must call for attention, and if medical, the internist called in and the case turned over to him. In other words, the kidney will undoubtedly return to its normal position with gain in weight if proper posture be instituted, and external support given, a secondary but important factor.

However, if the loss in weight persists and the patient directs her symptoms and signs toward the kidney, and she is a fair surgical risk, without other complications, and the laboratory findings bear us out in our conclusions, we recommend operation for correction of the displaced organ. Thus it will be seen that in these loss-of-weight cases but a small percentage go to operation for kidney position correction.

A goodly number will warrant surgical interference for another cause and many will be referred to the internist for treatment.

Again, if the kidney does not return to normal position following an operation for other conditions, or after the internist has put weight on the patient in a non-surgical weight, loss entity and the kidney persists in giving symptoms and signs, we recommend operation later on. This, of course, is done after posture and external support have failed. Our statistics show that about 2 per cent. of these cases require secondary procedure to correct the kidney displacement.

(c) *Congenital Malplaced Kidneys (Free or Attached)*.—Here we find a type of abnormally located kidney which in the majority of instances is best left untouched. This type of kidney is seldom diagnosed as such pre-operatively except by coincidence during routine urinary tract investigation including X-ray of the parts with lead catheters *in situ*.

Now and then a case will be met where some prominent symptom, such as pain, is referred to a definite localized area other than those generally found, containing a definite standard surgical condition of a more or less acute nature.

By the process of exclusion in differential diagnosis, it is determined that the symptoms come from the congenitally malplaced kidney while no real pathology exists within the kidney substance. Possibly at operation no macroscopical alteration has taken place about the ill-placed kidney. However that may be, pressure on a neighboring nerve flexus or branch, mechanical interference with physiological functions in greater or less degree, the cramped position of the kidney itself, including the approximal end of the urethra, or some such mechanical alteration, may be the root of the evil.

In these cases alone, and they are by far in the minority, should we resort to surgical procedure. It may be stated, however, that in these few cases where the symptoms are very prominent and no other cause can be found, such surgical intervention is warranted, and will generally yield satisfactory results.

Under this head may be included the supernumerary kidneys which are occasionally found. We do not refer to the single kidney properly located, or the hypertrophically nodular type which gives no signs or symptoms, or the one which is doing its work normally, no matter how markedly deformed physically. On the other hand,

we now and then find a case where there are three well-formed kidneys, the third being malplaced and causing marked signs and symptoms. This kidney may be placed well up under the diaphragm behind the stomach; attached to the spinal column in the centre of the posterior abdominal wall; deep down in the pelvic fossa, encroaching upon the viscera therein, attached high up to the posterior margin of the liver; encroaching upon the kidney, or pancreas, or in any other locality. We may also find this supernumerary kidney isolated with an entirely separate ureter entering the bladder. The ureter may join the ureter of the kidney of the same or opposite side. Whatever the malformation or connection may be, if this kidney as an accessory is found to be the cause for ill health, either by pressure, imposition upon other parts, deformity, or twisting on its own axis, pressure upon nerve trunks, branches or plexuses, etc.; in other words, if this supernumerary kidney is found as the only cause for symptoms or signs severe enough to produce ill health, we believe it should be dealt with surgically and removed. Of course it goes without saying, that it should first be ascertained that the other kidneys are functioning normally. On the other hand, if this type of abnormality is found in the ordinary routine physical examination and in no wise are the symptoms and signs reverted to the condition, the kidneys should be left alone. It is functioning well, and beyond doubt gives the patient ultra health and decreases his liability of disability, should the other kidney or kidneys become diseased. This class of kidneys are therefore in the minority surgically and usually pass as merely a curiosity.

(d) *Occupational or Form of Dress*.—Now and then we meet a case wherein the kidney has become displaced or deformed because of some special type of vocation, or because certain parts of the clothing have been worn too tightly or have exerted too pronounced a pressure. This type of kidney will not give pronounced signs or symptoms in the average case. However, now and then we find that the kidneys of this class will give pronounced symptoms. Every effort should be made to correct the misposture or deformity of the kidney involved by removing the cause, and if necessary assisting with a proper form of temporary external support. This will generally give results quite satisfactorily. However, if the pronounced symptoms do not abate to the point of relief, surgical interference is the final move, and at times should be used. Much conservatism

FIG. 1.



CASE No. 17-234

APRIL 4, 1910.

Arrow heads point to estimated kidney area (right) confirmed at operation. Old contracted kidney shell containing some organized fibrous tissue. Nephrectomy, radical dissection. No recurrences.

FIG. 2.



CASE No. 26-21

JULY 20, 1916.

Arrow heads indicate two stones in pelvis of left kidney. Removed. Recovered.

should be shown in these cases and only as a last resort following the failure of all other methods should we institute surgical treatment.

3. *Nephrolithiasis*.—This condition is found to be of a relatively frequent occurrence as shown by the X-ray. Many times stones in the kidney are found only in a routine physical examination including the X-ray procedure. In many instances, also, no symptoms are relative to the kidneys.

We do meet many cases of renal colic so called, persistent herna-turia without pain, or even with a dull pain over one or both kidney regions. This pain or ache is referable to the presence of stones in kidney, as shown by the X-ray. On the other hand, it is not an infrequent thing to find a calculus in the kidney during an exploratory laparotomy when there was no suspicion of such trouble, and the X-ray was negative.

Included under this class of kidneys should be urethral calculi which are not always recognized preoperatively and will now and then be found during exploration within the abdomen. These calculi are composed of uric acid, calcium salts or phosphates. The density of these various deposits will vary the X-ray picture as to detail. These formations gather about a nucleus, such as a bit of mucus or a blood clot. The presence of calculi in the kidney, or even at times in the ureter, as in several other kidney conditions, may be concomitant with some other more acutely expressed pathology elsewhere. On the other hand, many are the cases in which the specific signs and symptoms are definitely referable to the calculi.

We believe that whenever calculi are present in the kidneys or ureter they should be removed. This stand is taken because sooner or later these calculi will produce a serious condition which will demand surgery at a less favorable time. The better the general condition of the patient, the better the surgery and consequently the more favorable the results and pronounced the relief.

If we have a case of acute pathology and the calculi are independent of the condition, we care for the acute condition first. If the condition warrants, the kidney or ureter condition is attended to at the same time. However, we believe this secondary procedure should not be undertaken at any great risk, as it can just as well be done at another time when conditions are more favorable to the patient.

We do firmly believe that any calculus formation in the kidney

or ureter warrants surgical interference sooner or later. The earlier it is done the better if the condition of the patient, from a general point of view, will warrant the undertaking. On the whole, any stone in the kidney or ureter is surgical without exception, when the patient is under seventy years of age. This is with or without the presence of symptoms. In other cases of advanced years, over the threescore and ten, when the symptoms are marked, the surgical field yields best results if the patient is in fairly good condition generally.

4. *Tuberculous Kidney*.—In tuberculosis of the kidneys, we are dealing at once with a true surgical entity. The main facts in forming judgment on any case depend upon the resources of the laboratory for the diagnosis. To make the diagnosis early, as is always beneficial in so far as results are concerned, is not always an easy matter.

Every case that presents itself for examination, which has a history of frequent micturition, polyuria, dull pain in loins, the urine showing turbid with a fresh blood present, always makes one suspicious of a tuberculosis somewhere in the genito-urinary tract. The presence or absence of tuberculosis elsewhere in the body has no great significance.

However, the presence of tuberculosis in the husband or wife is of great importance in a diagnosis in the copartner. As Caille states: "Infection certainly takes place through direct contact." The disease is always insidious in its onset, as it may travel from the ureter up to the kidney or *vice versa*. The primary infective point acquires seed through hæmatogenous channels as far as its spreading is concerned. At least it is wise to state this in drawing conclusions in the majority of cases. The last statement must not be understood to mean that all kidney tuberculosis is hæmatogenous in origin. What we mean is that, when the disease is acquired in the very beginning, the start must be made by direct contact when the presence of tuberculosis is wanting elsewhere in the patient. On the contrary, if the patient has tuberculosis elsewhere, possibly in the lungs, and it is suspected and found in the genito-urinary tract, undoubtedly the origin of the infection in this tract is through the blood stream. Here is where we might differ from Caille in his broad statement just quoted.

Binney states that about 30 per cent. of surgical infections of the kidney are tuberculous. He also further states that this disease of the kidney occurs most frequently between the ages of fifteen and

FIG. 3.



CASE NO. 15-189.

MARCH 1, 1914.

Arrow heads margin area of shadow cause not determined until operation. Large kidney abscess found. Nephrectomy, drainage, recovery.

FIG. 4.



CASE No. 16-428.

DEC. 6, 1911.

Arrow heads indicate stones both kidneys. Confirmed and removed at operation. Recovery..

thirty-five years. He has, however, recorded cases as early as two and one-half months, and as late as seventy-five years.

From this review of the broad field of endeavor of Binney, we cannot but always be on guard for a tuberculous infection of the kidney, and thus give the patient the benefit of the doubt in making a differential diagnosis. Binney agrees in part with Caille in stating that he finds unilateral tubercular kidney infection is practically always hæmatogenous in origin.

In our own work we have found that tuberculous infection of the kidney is found most often in women. We can offer no logical explanation of this. However, we have seen many cases wherein no special definition of symptoms or signs pointed toward the kidney yet by exclusion and most careful and long-drawn-out observation, the final result has been a suspicious tuberculous kidney. This surgical interference has proven to be the fact.

When a patient comes to us with the complaint of vesical irritation, tenesmus, passing a smoky urine or one with slight streaks of blood, even feathery in appearance, regardless of pain, temperature, loss of weight or other usual signs or symptoms of tuberculosis, we are always suspicious of tuberculosis in the kidney.

The X-ray seems of little aid except to exclude the presence or absence of stones. Even the presence of stones will not always exclude a concomitant tuberculous infection, which we found thus present in two cases.

Whenever found, a tuberculous kidney is always surgical. We must not overlook the ruling out of the smegma bacillus in the laboratory when seeking the tubercle bacillus. Also, we must bear in mind the unilateral appearance of this infection in kidneys and the liability of a descending infection to the bladder and then ascending to the other kidney by contiguity.

As in tuberculosis elsewhere the earlier we make the diagnosis, the more favorable will be the final outcome. Remove the affected kidney and entire attached ureter far beyond the point where tubercles can be seen. Give the field a good chance to drain freely. Let the parts granulate in solidly about the site of nephrectomy, and keep the patient under strict surveillance for two years.

If we can make a diagnosis very early and go at the matter in hand in a radical way, we can save the good kidney from contiguous

extension and feel quite certain of a favorable outcome in most cases.

5. *Septic Infection.* (a) *Acute.* (1) *Primary.*—Acute septic infection of the kidney is not an extremely rare condition. In fact, where we have a sapræmia or pyæmia, we often meet at autopsy that type of kidney filled with multiple minute abscesses. This type of kidney comes under the secondary heading and will be considered then.

However, now and then we meet a kidney which gives precipitating symptoms and signs of the fulminating type. Under this class of kidneys we recognize the forms: metastatic abscesses, perinephritis, and a septic infarct.

1. *Metastatic Abscesses of Kidney.*—Acute infections of the kidney of primary nature are caused by bacteria brought to the kidney from distant parts of the body through the blood or lymph channels. As the kidney tissue itself is moderately resistant to any infection, we may presume that this multiple abscess formation could not occur without first having lowered resistance in the cellular construction of the affected kidney. In other words, metastitis resulting in multiple abscess formation in the kidney generally occurs where there is previous existing nephritis. The kidney has lost that normal amount of resistance and becomes a victim of intrusion.

The pathological pathway is relatively clear. First we have a kidney which is sick unto itself, but not organismally infected. Then comes along some intercurrent disease as typhoid fever, pneumonia or the like. Recovery is made from the later conditions, but is promptly followed by a multiple abscess formation in the kidney substance. The patient does not recover promptly from the systemic condition. He begins to pass quantities of pussy urine loaded with bacteria. He may or may not run a hectic course. In the majority of instances he does not, as the kidney tissue is being well drained.

The diagnosis is made on the continued run-down condition, persistent presence of pus in the urine, known previous existence of nephritis, cystoscopy showing cloudy urine coming from one or the other ureters and not infrequently both. Catheterization of the ureters will determine the extent of involvement of each kidney.

It is not always that surgical interference is best in this type of kidney. Not infrequently this kidney lesion will run a self-limited course and heal up, leaving a fractional kidney. However, there are

FIG. 5.



CASE NO. 18-321

MARCH 5, 1917.

Arrow heads point towards stones lower pole, right kidney. Nephrectomy because of severe necrosis. Recovery.

FIG. 6.



CASE No. 20-428.

AUG. 5, 1916.

Stone in right ureter producing severe colic Removal has given permanent relief for four years.

times when the multiple abscesses become confluent and rapidly destroy too much of the kidney tissue. For this reason these cases should be put under strict observation and the quantity of pus and kidney function carefully noted at regular intervals. Should the waste and destruction exceed the repair for any period the kidney should be opened and drained. These cases do not demand nephrectomy as a rule.

This is so for several reasons. The uninvolved tissue of the affected kidney will continue to function after drainage has healed the destroyed parts. The other kidney may be likewise involved, but to a lesser degree and, if drainage only is instituted, not as much risk is run regarding the life of the patient. Should nephrectomy be done, and the other kidney be sympathetically aggravated, untoward results would be certain. Drainage of the most involved kidney will help to safeguard this pending calamity.

Thus metastatic multiple abscess kidneys, if dealt with surgically, should always be so treated after other means of treatment have failed and then the kidney should be drained and not removed.

Perinephritis.—The soft structures surrounding the kidney are not resistant to infection as a rule. This field of question is one yielding satisfactory food for the bacteria invading. Often the infection will spread very rapidly and the extent of involvement becomes unlimited.

Pain in the lumbar region radiating to the testes and thighs. This pain is severe, the corresponding renal area is very tender to digital pressure, and this region is generally rigid and often œdematous. At times we have a *necessitatus* pointing which makes the diagnosis relatively easy. We may have chills, fever, furred tongue, vomiting, stupor and even delirium. The patient does not walk stand-up straight, but with body inclined toward the affected side. The urine often is negative, especially if all of the infection is extraneous. A careful differential diagnosis must be made and lumbago, spondylitis, hip-joint disease, and even at times an acute appendix must be ruled out. Once the diagnosis is made the procedure is surgical and early interference indicated. A wide opening and free drainage will give the desired results if done early. Perinephritic abscess is a true surgical entity always.

Septic Infarct.—Septic infarct, or focal suppurative nephritis

of Whiting, is of course embolic of origin. The infection is brought to the kidney through the lymphatics or general circulation. Traumatism seems to act as the aggravating cause in many cases, but of course some distant point furnishes the bacterial embolism. The tonsils, prostate gland, or some distant extremity infection is often found to be the real source.

This condition generally has a rather sudden onset, complicating the convalescence from trauma. It is ushered in by a chill, sudden upstart of temperature, pain, and is soon followed by a leucocytosis. Urine from the affected kidney contains pus and blood. A most careful differential diagnosis must be made, as often this condition will simulate other abdominal pathology. Pain at the costo-vertebral angle is quite significant, according to Brewer.

Operative procedure is not warranted in these cases, unless more than one marked attack of the recurrent embolic type occur. As a rule the patient with but one attack of the pathognomonic signs and symptoms will recover. However, if repeated attacks occur, nephrectomy should be done following rigid assurance that the sister kidney is in good order.

2. *Secondary*.—Under septic infections of the kidney we can consider six conditions: pyelitis, pyelonephritis, pyonephrosis, an infected hydronephrosis, mixed infection associated with tuberculous involvement, and associated with calculus formation.

If we consider these conditions for a moment, in combination it will be seen that all of these infections are ascending. Originally the trouble was in the urethra or bladder and gradually went up to the kidney through the ureter. For this reason secondary kidney infections generally are more subacute or chronic in form and are more apt to be bilateral. Fortunately, however, when operated upon, one kidney only is bearing the brunt of burden while the other kidney is shown to be resisting quite well. However, we can consider secondary infections as ascending in development.

Pyelitis.—This we consider strictly as an infection confined to the renal pelvis. We also find that the colon bacillus is the most frequently offending organism. Pyelitis, strictly as such, is of short duration. By this we mean that it either gets well or soon gradual extension into the calices follows.

Preceding the pyelitis we either elicit a history or learn that a

cystitis, urethritis, suppurative prostatitis, orchitis, epididymitis, or similar conditions had been present for some time.

The usual symptoms are pain in the loin or lower back, frequent micturition, some fever, and a general malaise accompanied by pus in the urine, sometimes blood and the absence of urinary findings involving the kidney tissue itself. This with the history makes the diagnosis fairly easy. Generally, this condition demands no surgical interference. Occasionally a large collection of pus, sacculated in the pelvis and rapid in accumulation, may demand incision and drainage, but never nephrectomy. These cases ordinarily get well rapidly.

Pyelonephritis.—This is merely an extension from the pelvis into the kidney substance via the calices. The symptoms are merely the exaggerated form of those found in pyelitis. The urine shows kidney tissue involvement. Many of these cases get well without any surgery. However, if it is proven that abscess is present in the kidney and the sister organ is working well, operation should be done at once.

Nephrectomy should not be done unless the majority of kidney tissue is destroyed. Then again, as this condition is so often bilateral, we should always make sure of the activity of both kidneys previous to any surgical interference. Of course, if the kidney has been shelled by the infection, nephrectomy should be performed. Otherwise nephrotomy and drainage are the chosen method.

Pyonephrosis.—This condition may follow the previously existing two conditions just described. On the other hand, this condition is so often associated with adding complications to a tubercular condition, the formation of a calculus or a hydronephrosis. Many times this condition is found bilateral, thus every measure should be taken to determine the separate condition of each kidney. Generally, however, one kidney is much more involved than its sister organ, and direction should be pointed toward the more involved organ.

The chief symptoms seem to be pain and persistent, abundant pyæmia. It is generally quite easy to palpate the kidney, which is large and rapidly increases in size. This condition always demands surgery. If the patient's general condition warrants and it has been established that the other kidney is functioning well, and either not at all or not severely involved, nephrectomy should be done at the first sitting. Otherwise, the two-stage operation is best, doing nephrotomy and drainage first and later, when general conditions have

improved, to do nephrectomy. This is always a surgical entity, however, and demands moderately conservative surgery.

Infected Hydronephrosis.—The diagnosis of hydronephrosis should be made as taken up under this head. When it is infected, as can be established by the urinary findings, it is surgical, and nephrectomy is the operation indicated. Fortunately this is a unilateral condition.

Mixed Infection with Tuberculosis.—This has been covered under the heading of tuberculous kidney. The mixed infection does not alter the procedure. The diagnosis is fairly easy by urinary findings and it demands nephrectomy in each instance.

Infection Complicating Calculus Formation.—The diagnosis of the calculus presence and the complicating bacterial invasion is not difficult. X-ray in the one instance, and urinary findings in the other, establish the facts. Surgical interference is always indicated. Nephrotomy, removal of the stones and drainage give the desired results in the average cases, especially early ones.

(b) *Chronic (Cold Abscess).*—Occasionally we run across a kidney which contains within itself well-defined and walled off, a large collection of pus. The patient comes to us because he is getting run down and feels out of tune. Possibly he has been losing weight for the past year or two and has night sweats and marked loss of strength. He has also noticed that he has grown pale or ashy and cannot seem to exert himself without fatigue coming on quickly.

In examining these cases we find a tumefaction in one or the other hypochondriac regions or in the flank. This tumefaction is round, of good size and generally symmetrical. Examination of the urine may, or may not, reveal the presence of pus. In fact, urinalysis at times throws no light on the subject. Individual kidney function, however, shows the action of the kidney of the affected side very low or even nil.

Microscopical examination of a three-hour stained sediment may, or may not, reveal the presence of a specific organism. Culture of this sediment may, or may not, produce culture growth on various tried mediums.

Constitutionally the patient is below par. Very often we find him running an afternoon rise in temperature, or even a steeplechase thermal scale may show under a fourteen-day observation.

Some of these cases will give a very short history comparatively.

Sometimes this history will not cover more than sixty or ninety days. Then again a period of one or two years will be shown by the history. In times past, we have divided these cases into those of short duration covering a period of not over ninety days, and those of long duration covering from ninety days to two years or over. Not often will the history go over two years, but it may run as far as five years.

In the cases of short duration we have been able to isolate the tubercle bacillus, gonococcus, pneumococcus and, in one instance, the colon bacillus and, in another, the staphylococcus albus. As a rule, in the short duration cases some specific organism can be isolated.

In these cases we have noticed that stained smears of a three-hour sediment show organisms which have a very granular protoplasm and sometimes rather crenated periphery. The nucleus is not well defined and they take the stain poorly, appearing in pale dress. We have also noticed that to produce any appreciable growth from these sediments requires a highly nutritious medium and rather lengthy incubation. The colonies are small and discrete and the growths do not increase by transplantation. On the contrary, in the average case they will die out on the first attempt to transfer to a fresh medium. They have a marked tendency to neutralize themselves and the patient becomes semi-immunized and the pus has a tendency to become sterile.

In the long-standing cases no organisms can be demonstrated in a three-hour sediment stain. Growth is not forthcoming in the best of culture media. The urine shows numerous pus cells which have a granular protoplasm and many of these cells have no nucleus or a very minute one. In many cases the periphery of the pus cell is broken in its continuity and has passed through a disintegrating stage. Also we note no marked cast formation but a marked presence of debris and granular, ill-defined, disintegrated kidney cells. The kidney tissue is fast undergoing destruction.

The diagnosis in these cases is not easily made pre-operatively unless in the short duration stage. The later stage will sometimes give a clue and by exclusion the diagnosis of cold abscess formation can be made tentatively. However, an acutely cited differential diagnosis must be gone over if we are to even make a legitimate guess. At times nothing shows in the urine, and at operation the cold abscess is found to be entirely perinephritic. Here the diagnosis is most difficult and the decision tumefaction cause undetermined.

These cases may be classified as metastatic, lymph channel in origin, with or without a previously known distant origin.

Any case of cold abscess of the kidney where the kidney tissue itself is involved to any extent so that more than half of the kidney is destroyed, warrants nephrectomy after good proof on the part of the sister kidney. At all hazards, these cases are surgical. If one-half or more of the kidney substance remains intact, nephrotomy and drainage should be the procedure of election. If the cold abscess is perinephritic the abscess should be opened and drained with every precaution shown and protection given the kidney and surrounding tissues. Adhesions should be left untouched after the shell has been well evacuated.

At times a combined perinephritic and kidney substance cold abscess is found. Undoubtedly this is of perinephritic origin, and has later broken through into the kidney substance. In these cases the same method of surgical procedure is required. If one-half or more of the kidney substance is left, open and drain; if the involvement is greater, do nephrectomy and establish drainage well down into the cavity, but all parts should be well walled off previous to opening.

In cases where no organisms have been demonstrated in the laboratory previous to operation, the pus is sterile, gives no growth and shows negative in stained smears. If cultures have been successful pre-operatively, a like growth can be obtained from the pus evacuated on the table. The majority of these cases are in the long-duration class and thus show sterile pus. At least all of these cases are surgical and the extent of interference is governed by the amount of kidney tissue destruction.

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PYELOTOMY AND REMOVAL OF STONE FROM THE KIDNEY; SUBACUTE SEMINAL VESICULITIS WITH TRIGONITIS

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WE have one or two interesting cases for examination and diagnosis this morning. Some of the patients have undergone at least part of the routine diagnostic procedures. This includes complete urinalysis, blood examination, röntgenographic examination, cystoscopy and ureteral catheterization and bacteriologic examination of the urine gained from each side. I do not include pyelography in my routine examination, because the diagnosis in many cases can be made accurately without it. However, I believe that conditions not infrequently exist in the upper urinary tract in which pyelography will be of great importance in diagnosis. Renal functional tests are likewise included in our routine examination, though they frequently are misleading in the extreme and unfortunately just in those cases where we are most anxious to determine the functional activity of both kidneys with the view to removing one of them. There is considerable literature to substantiate this statement. Time will not permit my developing completely my objections to certain renal functional tests which are based on the elimination of a stain, such as indigo-carmin or phenolsulphonephthalein.

I believe that a much better conception can be formed by determining the percentage and amount of urea excreted by each kidney and by the estimation of total solids excreted, as well as the estimation of the blood urea. Cryoscopy of the urine from the respective kidneys and the determination of the electro-conductivity of the urine are in my opinion of much greater value and much more reliable than the estimation of the amount of dye excreted in a given time.

CASE I.—This patient is a young woman of thirty years, unmarried, who states that she has had several attacks of severe pain which starts in the left lumbar region and is projected downward and forward to the left groin. The first attack was six years ago, the details

of which she has forgotten, other than that it started in the region of the left kidney and was of considerable intensity. She did not notice any blood in the urine at the time, but the distress and soreness persisted for a week or ten days. At this time she noted some pain and frequency in urination. Since that time the attacks have been of similar character and have in the last eighteen months recurred with greater frequency. The pain has been of greater or less severity at different attacks; morphia was required only twice to relieve it.

Examination.—The patient is very slender, weighing only 105 pounds. Her color is poor. The mucosæ are anæmic. She suffers from pyorrhœa alveolaris, and most of the teeth are affected. She is at the present time under the care of dentist for relief of this condition. Heart and lungs are negative, except for slight prolongation of the expiratory murmur in the right apex. No tumor masses are palpable in the abdomen. The liver and spleen are likewise not to be felt. The right kidney can be palpated; the lower pole is readily felt. The left lumbar region is sensitive to deep pressure and there is some "muscle defense." The lower pole of the left kidney is also palpable. Examination of the urine (catheterized bladder specimen) shows a trace of albumen, several white blood-corpuscles and several reds to the field. There are a few hyaline casts present. Urea output is normal. The striking feature is the presence of red blood-corpuscles. Several whites, and a few hyaline casts are not unusual findings in urine in which there is little or practically no pathology. There is no sugar nor acetone present.

Cystoscopy.—It is well to carry out a cystoscopic examination in the same manner each time, paying attention to the various anatomic regions in the same order so that no pathology or item of interest is passed over or neglected. Likewise one's records are more useful and complete if a routine mode of examination is always carried out. We first note that there is no difficulty in passing the instrument, neither obstruction nor complaint that the procedure is painful. The urine in the bladder is grossly quite clear, although there are some "flakes" present and the urine is rather concentrated. We proceed to "wash out" the bladder through the cystoscope until the wash fluid returns absolutely clear and "flakes" no longer are seen. In this instance it takes but a few moments to do so. The light of the cystoscope having previously been tested, we can proceed with our

examination. We first locate the "air bubble" which indicates for us the vertex of the bladder; it appears as a bright, shiny pearl in the upper part of the cystoscopic field. The size of the air bubble is variable. In this instance it appears to be the size of a hazelnut. Having thus located the vertex of the bladder, we note whether there is any pathology present. There is none. The mucosa is normal in color, there is no exaggeration of the muscular walls as evidenced by trabeculization. There are no exfoliating patches of epithelium. There is no tumor dependent from this portion of the bladder. We next withdraw the instrument slightly and examine thoroughly the internal vesical orifice, which should be smoothly concave throughout its circumference. It is so in this case. There are no submucous hemorrhages noted in its entire circumference and there is no œdema. We now examine the trigone or base of the bladder. It shows slight congestion, especially in its left half. The blood-vessels are more prominent than normal and the color is distinctly redder than is normal. We now examine the ureteral orifices. The right ureteral orifice is negative; that is, it is slit like, of even contour, contracts rhythmically and is not œdematous, nor is it surrounded by a halo or zone of congestion, inflammation or œdema. The left ureteral orifice, however, presents a somewhat different picture. There is a zone of congestion about it extending for three-eighths of an inch into the trigone on that side. The margins of the orifice are slightly swollen and the even contour is destroyed. The contractions of the ureter are regular and rhythmic, but a somewhat flocculent urine is ejected, while that on the opposite side is clear. There is no macroscopic blood present.

Now that the house surgeon has returned from the X-ray room with the plates taken of this patient yesterday, we will stop to examine them. The entire genito-urinary tract was rayed, both kidneys, the full course of both ureters and the bladder. It will be easily seen that there is a shadow in the left kidney region, dense, irregular and sharply outlined, in a position and shape corresponding with the pelvis and two calices of the kidney. This undoubtedly is a large stone in the pelvis of the kidney which has been present for many years. Pyelography, while not done in this instance, would unquestionably show merging of the shadow cast by the filling fluid and that of stone in the pelvis of the kidney.

Operative Indication.—Pyelotomy and removal of the stone, with primary suture of the opened pelvis.

CASE II.—The next case is a young man, thirty-four years old, who states that he has noted a sense of fulness in the bladder for a few days. Also that urination has been more frequent recently. He voids six or seven times a day and arises twice at night. He also states that yesterday and to-day he has seen blood in the urine and that at the end of the act there are a few drops of whole blood present. The symptoms are aggravated after standing for several hours and after walking. He is much worried about his condition and comes to the hospital for relief.

The patient is well nourished, his color is good and he evidences no particular signs of distress. Urinalysis made yesterday morning reveals a trace of albumen, many pus cells and many reds to the field. There are many mucous shreds and flocculi in the first portion of urine voided. Stained sediment reveals various bacteria; some Gram-negative diplococci are seen extracellular. His blood is negative, both reds, whites and hæmoglobin percentages normal.

X-ray plates made yesterday reveal no pathology in the kidneys, ureters, nor bladder. There are no shadows, no malpositions nor abnormalities in size or contour noted.

We will now proceed with the general physical examination, which reveals nothing in a positive sense. Heart and lungs normal. No masses palpable in the abdomen. Kidney regions not sensitive to pressure and the kidneys not palpable. Pressure over the bladder causes no discomfort.

Cystoscopic Examination.—The patient is nervous and somewhat high strung, so we will inject both the anterior and posterior urethra with some 1 per cent. novocain solution. This solution requires at least ten minutes to produce its effect on the urethral mucosa. . . . Now that the solution has been in a sufficient length of time we insert the cystoscope and will irrigate the bladder through it. The bladder urine is slightly red tinged and is not perfectly clear. After a few syringes full of sterile water have been used the fluid is quite clear and we can proceed with the examination. The air bubble is located and the bladder vertex examined and found negative. The internal urethral orifice is likewise negative, the contour throughout is smooth and concave. The trigone is seen to be distinctly reddened,

especially in the right half. Is this redness due to congestion or to a genuine inflammation? It is an inflammation of the trigone, or trigonitis, because the blood-vessels are no longer seen coursing in the walls, but are obliterated by a diffuse, velvety redness of the mucosa. The intense inflammation lessens as we note the left half of the trigone. The right ureteral orifice naturally partakes of the inflammatory reaction with which it is surrounded. The lips are slightly swollen, but contraction is rhythmic and the whorl produced by the urinary jet does not show any flocculi.

The patient is evidencing some distress, so we will not proceed with ureteral catheterization at this sitting. Besides, cases with findings of this character have come under our observation before and lead us to examine most carefully the prostate and seminal vesicles, especially so since various bacteria were found in the centrifuged specimen, among which was a Gram-negative diplococcus. On inquiry, we learn that the patient contracted a gonorrhœal urethritis some two years ago, and has considered himself well for over a year. (This fact should have been elicited in the history on admission of the patient to the service.)

The next procedure is a rectal examination which will be carried out now, after the removal of the cystoscope and while the bladder is still full of water. We first examine the prostate. It is diffusely enlarged to a moderate degree, rather more than normally sensitive and somewhat boggy in consistency. There is little difference in the two lobes. We now pass the examining finger higher into the rectum and we are able to palpate an enlarged, tender, right seminal vesicle. At this time attention should be called to the fact that we cannot palpate the vesicle in its entirety, but only the lowermost portion and the ampulla of the vas deferens. This fact is important in the care of infected vesicle by stripping, because the so-called vesicle-stripper permits one to reach all parts of an organ. A certain amount of experience is necessary to use a vesicle-stripper with perfect safety; however, this is easily acquired.

The right seminal vesicle, therefore, evidences definite signs of inflammation, namely, enlargement and tenderness. It is now gently, but as thoroughly as possible expressed, and the patient is requested to empty his bladder. The water, which was perfectly clear, is seen to contain many flocculi and large masses of cell detritus

and pus. The microscope shows, as those of you who wish to may come down and see, epithelial débris, polymorphonuclear leucocytes and bacteria. Stained specimen shows diplococci some of which are intracellular and are morphologically similar to gonococci.

To recapitulate briefly, our patient with symptoms of bladder pathology presents subacute seminal vesiculitis of long standing, which by contiguity has produced a localized trigonitis with symptoms.

Therapeutic Indications.—It is well to treat these cases conservatively for a period to determine whether a result can be obtained by gentle, but systematic, vesicle stripping and prostate massage. This procedure is followed by instillation into the bladder of 10 per cent. argyrol or 10 per cent. silvol, three times a week. Hot sitz baths are of great value and should be given before retiring at night. The frequency and dysuria are satisfactorily relieved by rectal suppositories, containing ichthyol and belladonna. We shall present this case in two weeks and observe whether by this method of treatment there has been the anticipated improvement.

OBSERVATIONS REGARDING THE DIAGNOSIS AND TREATMENT OF BRAIN TUMORS

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BRAIN TUMORS are rarely diagnosed with any degree of certainty before there is present a marked increase of the intracranial pressure—the most notable exception frequently being tumors of the cerebello-pontine angle. The treatment of brain tumors is a surgical one—their localization and removal as early as possible or merely a lowering of the resulting increase of the intracranial pressure by means of an early cranial decompression and drainage. As brain tumors are malignant in almost one-half of the cases in children and in two-thirds of the cases in adults, the necessity of an early palliative operation of cranial decompression to lessen the headache and to spare the vision by lowering the increasing intracranial pressure is apparent; the operative removal of tumors of this type is naturally of secondary importance and their localization need not be more accurate than “supratentorial” and “infratentorial” in order that the visual impairment and the intense suffering of these patients be avoided by an early subtemporal or suboccipital decompression respectively; the permanent drainage of the ventricles, when blocked, is essential.

In the diagnosis of tumors of the brain one of the main causes for the usual delay in reaching a positive conclusion of the presence of the tumor is the mistaken conception of the necessity for the existence of a measurable papillœdema to the degree of “choked disks.” An intracranial pressure sufficient to produce the condition of “choked disks,” is necessarily an exceedingly high one, and if permitted to persist for a duration of weeks and even longer, it causes the formation of new tissue in the nerve head itself—a secondary optic atrophy of varying degree and therefore a permanent visual impairment. The earlier stages of papillœdema of a swelling of only one diopter (1D) and even of the more preliminary degrees of œdematous blurring and obscuration of the nasal halves and temporal margins of the optic

disks¹—these earlier periods of pressure changes to be observed in the fundi with the ophthalmoscope should, when present, be considered most suggestive and, together with the other signs of brain tumor, as being indicative of an increased intracranial pressure; the confirmatory registration of the pressure of the cerebrospinal at lumbar puncture by means of the spinal mercurial manometer is most helpful in many of the doubtful cases. It is in this comparatively early period in the formation of brain tumors and before irreparable pressure damage to the delicate nerve-cells has occurred that these patients can be offered the greatest amount of improvement, both temporary and ultimate. A papillœdema of a swelling of more than two diopters, that is, the condition of “choked disks,” rarely occurs unless the ventricles have been blocked either completely or partially, so that in reality a hydrocephalus interna of varying degree is produced, or if there is no ventricular occlusion, then the tumor must be of large size, as is frequently disclosed in either frontal or temporo-sphenoidal lobe; in these latter cases of large tumor formation, there usually exists with the papillœdematous changes of moderate “choking” of the optic disks, a large amount of connective tissue—an early stage of secondary optic atrophy and indicating that the increase of intracranial pressure is of slow formation and most probably due to a large supratentorial tumor, whereas in the presence of “choked disks” of high degree and yet little or no new tissue formation can be observed, this fundal condition is most suggestive of an acute ventricular blockage, either by a subtentorial or posterior basal tumor of variable size or by an occlusion of the aqueduct of Sylvius or of the foramina of the fourth ventricle by a meningeal exudate or adhesions. Merely because an accurate localization of the tumor cannot be definitely determined, no patient should be permitted to remain for a period of weeks and even months with the condition of “choked disks” associated with the formation of a progressive secondary optic atrophy, without an early operative lowering of the increased intracranial pressure; it is most infrequent that the localization of the lesion cannot be, at least, “supratentorial” or “infratentorial,” but if in these rare cases the localization can only be designated as “intracranial,” then a subtemporal decompression should be performed early to lower the increased intracranial pressure and thereby lessen the headache, save the vision, and at the same time

¹ *Archives of Ophthalmology*, Vol. xlv, No. 4, 1917.

ascertain with a blunt ventricular puncture needle the presence or not of ventricular blockage; if the ventricles are not dilated, then a posterior basal and subtentorial tumor is very improbable and therefore indicating a large supratentorial tumor—always remembering, however, the possibility of a small tumor in either cerebello-pontine angle without producing ventricular blockage and naturally, therefore, few, if any, œdematous changes in the fundi (the localizing signs of these “angle” tumors are easily elicited and, when present, they form a typical clinical picture); and if the ventricles are found to be dilated, then the lesion must be a posterior basal or subtentorial one, and permanent ventricular drainage can be immediately instituted by the insertion of linen strands through the subtemporal decompression and later the subtentorial tumor can be either removed or at least decompressed suboccipitally; if the tumor is in the posterior mid-brain and therefore an irremovable one, the patient will at least be greatly benefited and rendered comparatively comfortable by the subtemporal decompression and ventricular drainage. But to permit these patients to suffer intense headache, to become emaciated from the associated nausea and vomiting and to progress into the stage of total blindness merely because the cause of the high intracranial pressure cannot be localized accurately, this attitude cannot be condemned too strongly. If these patients having a high intracranial pressure from a non-localizable tumor are made comfortable and their vision spared by an early subtemporal decompression with or without ventricular drainage, then later the localizing signs of the lesion may develop, making possible the successful removal of the tumor—and the patient be not blind and otherwise irreparably damaged.

These are the two factors, therefore, in the diagnosis and treatment of brain tumors—the high percentage of malignancy especially in adults, and the lateness of a positive diagnosis of the presence of a tumor so that much permanent damage has been permitted to result from the increased intracranial pressure of even benign tumors—these are the two factors which have made this field of surgery a most discouraging one; and yet as the use of the electric ophthalmoscope becomes more and more common so that patients having the usual symptoms and signs of an intracranial lesion such as headache, vomiting, etc., may be examined with it early, a larger percentage of recoveries, both of life and of normality, will undoubtedly be obtained.

Naturally, tumors of the mid-brain and of other surgical inaccessible areas cannot themselves be removed except in the rarest cases, but their pressure effects can be so lessened and retarded by means of an early subtemporal decompression and drainage that it is frequently possible for the patient to remain at work and in comparative comfort for a period of months and of even two and three years; it is unusual, however, for these patients to live longer than three years.

Within recent years the value of callosal punctures, not only as a means of ascertaining the presence or not of ventricular dilatation and thereby assisting in the more accurate localization of tumor formations, but also of affording drainage of the cerebrospinal fluid in cases of ventricular blockage, has been very much overestimated. Ever since Bramann emphasized this method of exploratory puncture,* it has been heralded at intervals by various writers as not only a most valuable means of exploration but also as a therapeutic measure of drainage in conditions of internal hydrocephalus. In the presence of an increased intracranial pressure, a puncture of the corpus callosum is indeed a valuable aid in the diagnosis and localization of obscure intracranial lesions—whether the lesion is so situated that a ventricular blockage results or not; in these patients having an increased intracranial pressure, if the ventricles are dilated, then the lesion is posterior basal or infratentorial; whereas, if no ventricular blockage is demonstrated, then the intracranial lesion is a supratentorial one—important data diagnostically but otherwise the callosal puncture is in itself of no real therapeutic value. Naturally, if there is not present a definite increase of the intracranial pressure as registered by the ophthalmoscope, then there is no object in performing a callosal ventricular puncture, as even a partial ventricular blockage produces a marked increase of the intracranial pressure which can be readily demonstrated. Now, if a callosal puncture does reveal ventricular dilatation, then the advisability of approaching the lesion through a suboccipital incision must be considered, since the callosal puncture in itself is of no permanent therapeutic value, whereas if a subtemporal decompression instead of the callosal puncture had been performed, then not only could the dilatation of the ventricles have been ascertained but an adequate ventricular drainage instituted by means of the linen strands together with the decompressive effects of the explora-

* *Arch. f. Klin. Chir.*, 1909. v. 90, p. 689.

tory operation itself; in this manner, a large percentage of patients having posterior basal tumors and malignant growths of the cerebellum, as well as the rather common subtentorial tuberculomata occurring so frequently in children and in young adults—these patients can be “tided” along comfortably without the serious immediate risk of a suboccipital exploration and decompression. And on the other hand, if the ventricles are not blocked as can be easily and safely ascertained through a subtemporal decompression, then at least a lowering of the increased intracranial pressure has been obtained, exploratory punctures of the ipsilateral cerebral hemisphere in search of the lesion are possible and the patient is not allowed to develop a secondary optic atrophy and even blindness itself while waiting for the tumor to localize itself. For these reasons, it does seem to me that the operation of callosal puncture—and it is an operation requiring a careful preparation of the patient, anaesthesia, strict asepsis and a practiced technic—is most limited in its scope and that not only can its value of ventricular exploration be also secured by means of the subtemporal method, but in cases of supratentorial tumor the lesion itself may be located and even removed by the almost equally simple operation of subtemporal decompression; again in cases of ventricular dilatation, the blocked cerebrospinal fluid can be drained successfully and at least for a period of months through the subtemporal area by means of the linen strand drainage, whereas the callosal punctures must either be frequently repeated or be of only a temporary value. As a therapeutic measure, callosal-puncture drainage has again been lately advocated in conditions of internal hydrocephalus due to the usual cause—a former meningitis of varying degree. As the usual type of meningitis in newborn babies and in children is a diffuse one and the ventricular dilatation occurs only because the escape of cerebrospinal fluid from the ventricles happens to be blocked as an incidental pathology—merely permitting the blocked ventricular cerebrospinal fluid to escape through repeated callosal punctures would, at most, even if a callosal drainage opening remained patent, only lessen the ventricular dilatation and the condition of hydrocephalus interna would become altered to one of hydrocephalus externa in that the cerebrospinal fluid would not be absorbed through its normal channels into the blood-stream of the supracortical veins, since the stomata of exit in the vessel walls have been occluded by the

former meningeal process; it is for this reason that the drainage of ventricular cerebrospinal fluid in cases of internal hydrocephalus due to the usual cause of meningitis should always be beyond the intracranial dura in order that its absorption be possible. However, internal hydrocephalus, due to ventricular blockage by irremovable posterior basal and malignant subtentorial tumors, can be successfully drained, either temporarily by callosal drainage, or better still by the subtemporal route, into the normal subarachnoid spaces, where the cerebrospinal fluid will be absorbed in the usual manner by the supracortical veins and sinuses.²

In the consideration of brain tumors, the same differentiation between tumors of the brain itself and those of the cranial bones and dura must be remembered just as in conditions of so-called brain abscess; the statistics and case-reports of these latter conditions are most confusing in that merely because a purulent collection is found beneath the dura (and not subcortical)—these cases are so frequently labelled as ones of “brain abscess” and if a recovery of life is obtained, then the case is reported as a “recovery from brain abscess,” whereas the condition was only one of subdural abscess—usually well walled off from the underlying cortex, and naturally the prognosis is much more favorable than that of true brain abscess (subcortical and not supracortical);³ in my series of patients having true brain abscess, the mortality has been almost 80 per cent. as compared with the usual reported mortality rate of “brain abscess” of less than 50 per cent. In the same manner, tumors of the cranial bones depressing and even involving the dura and of the dura itself cannot usually be considered as brain tumors, and it is only when tumors originate in the brain substance itself or when brain tissue is so involved and even damaged by compression as to produce brain impairment, both functionally and organically, that the condition may be considered as one of brain tumor. If such a differentiation is kept in mind, then the reported statistics regarding the prognosis of patients having “brain tumor” will be less confusing; no extradural tumor can really be classified as a brain tumor, and only dural tumors extending into the brain substance with resulting tissue change can be included in that most serious group of true brain tumors where the malignancy

² *Amer. Journal of the Medical Sciences*, April, 1917, No. 4, Vol. cliii.

³ *Surgery, Gynecology and Obstetrics*, March, 1920, pp. 312-314.

and mortality are most high; in all case-reports of "brain tumor," therefore, the prognosis depends largely upon the character of the tumor itself, the tissues in which it originates and then the surgical accessibility of the tumor site.

With the exception of tumor formations involving either cortical motor area and fortunately of the rather common endotheliomatous type, and of tumor lesions compressing the pituitary gland, the resulting clinical picture can rarely be so well defined as by tumors situated in either cerebello-pontine angle; the majority of these tumors are benign fibromata of the auditory nerve and can only be included among "brain tumors" as a result of their neighborhood effects of compression: the early unilateral impairment of hearing (viii.) to be followed by a hypæsthesia of varying degree (v.) and a paresis of the peripheral type of the ipsilateral half of the face (vii.), and then by the increasing signs of unilateral cerebellar compression as elicited by the unilateral tremor, positive Romberg, unequal nystagmus and pointing tests, and associated or not with a partial blockage of the escape of the cerebrospinal fluid from the ventricles as demonstrated by the fundal pressure changes—these cardinal localizing signs cannot be mistaken and the prognosis is unusually favorable to the patient following the successful removal of a small tumor; naturally, a bilateral suboccipital exposure is essential to its removal with the minimum amount of operative cerebellar damage.

In this connection, the rather pessimistic attitude of the medical profession regarding not only the immediate, but also the ultimate prognosis of patients having brain tumors is well founded; the high percentage of malignancy—almost 70 per cent. in adults—together with the usual delay of months and even years in reaching a comparatively positive diagnosis that, even in the presence of a benign tumor formation, not only has the patient become irreparably impaired as evidenced by the visual, motor and sensory disturbances, but the more highly developed functions in the mental, psychical and emotional fields are profoundly affected as a result of the prolonged disturbances of the delicate nerve-cells—functionally if not organically. Similar to brain injuries with and without a fracture of the skull, it has become a popular belief that once a patient has had a brain tumor, that person is no longer the same again—whether the lesion has been successfully removed or not. And it is most difficult to conceive

that a cerebral lesion, and especially a tumor, can develop to the extent of producing sufficient localizing signs by affecting the adjacent nerve-cells of the brain as would warrant the risk of an exploratory operation without there having been produced a permanent impairment—not necessarily of gross mental or physical character, but of the more highly developed adjustments in the psychical and emotional reactions, so that, at best, the patient reacts more irritably to his environment, becomes petty and self-centred with a definite lessening of his emotional control; if the lesion has been so situated in or near the cerebral cortex that several convulsive seizures have resulted from the cortical irritation, then the prognosis is a most doubtful one and these latter patients, upon the successful removal of the tumor, should lead a most quiet country life in a mild climate and not be subjected to continuous mental and emotional strain of an active career; the danger of a “nervous breakdown” is a very imminent one aside from the lessened mental acuity and balanced judgment. When the degree of mental and emotional upset resulting from a small hemorrhage of but few drops into the internal capsule is considered as occurs in the form of apoplexy or from a thrombotic blockage of the same vessel, and these lesions affect only the motor and sensory pyramidal tracts and far from the cerebral cortex, then the amount of similar damage probable from a tumor formation in or affecting the cerebral cortex itself and the cell destruction necessary to its complete removal—when these factors are all considered, it is in only the rarest instances that patients having had the condition of brain tumor ever are as normal as before and their lives should be governed in this knowledge. Just as in conditions of brain injuries with and without a fracture of the skull, so in brain tumors, the first therapeutic indication is the relief of a high intracranial pressure when present, whether the lesion can be accurately localized or not, and thus the damage to the brain-cells is avoided or at least lessened, and then when the tumor can be accurately localized, it can be removed at a later operation with the minimum amount of cell damage due to a lowered intracranial pressure. The rational treatment of brain tumor, therefore, with but few exceptions, is a preliminary lowering of the increased intracranial pressure when present, even if the tumor is only a suspected one, and then if later its localizing signs appear, the tumor may be removed—and the patient is only

slightly impaired visually, mentally and emotionally. To permit these patients to become mental and physical derelicts from a high intracranial pressure merely because the site of the tumor cannot be diagnosed, simply lessens what little modern surgery can offer to these patients and tends to prolong the discouraging attitude of the profession toward these conditions.

"Pseudo-tumors."—In the presence of a high intracranial pressure prolonged over a period of weeks and even months, and frequently to the extent of secondary atrophic changes in the fundi with and without ascertainable localizing signs of an intracranial lesion and in the absence of demonstrable luetic, tuberculous, uræmic, diabetic and toxic systemic conditions—the most probable diagnosis is one of brain tumor and yet, especially within the past few years, this latter diagnosis has rather frequently *not* been confirmed, either at operation or at autopsy: merely a "wet," swollen, œdematous brain, and upon superficial examination alone, "practically normal." If no signs of a localized intracranial lesion appear—"merely an increased intracranial pressure"—these are the patients as well as the ones having tumor formations, who most frequently are permitted to become permanently and irreparably impaired, visually and physically as well as mentally and emotionally, by the prolonged effects of this increased intracranial pressure; inasmuch as there are no definite localizing signs in so many of these patients with and without a true brain tumor and, according to a belief at present firmly rooted in the profession, that no cranial operation should be performed until these localizing signs are demonstrable—and they frequently never appear or not until the patient is almost moribund and so irreparably damaged that any operation is hardly justified—they are the patients, and they form a surprisingly large percentage of so-called brain tumor conditions, in whom, either at a delayed operation or at autopsy, no brain tumor is to be found. (Naturally, the post-mortem examination is the only accurate method of determining the presence or not of an intracranial lesion, it being easily possible at an operation not to locate a brain tumor of even large size.) During the past six years, with each one of my neuro-surgical patients, both private and ward, I have insisted that the nearest relative sign a printed permission before the operation that, in event of the subsequent death of the patient, a post-mortem examination is to be allowed; during this

period since 1914, I have performed over five hundred cranial operations and in only two cases was this permission of possible post-mortem examination refused—and no operation was performed. It has been this ready coöperation of the nearest relatives that has made it possible in the patients who died to ascertain accurately not only the cause of death and, if the operator's mistake, a lessened danger of its repetition in future patients, but of the greatest importance, the correctness of the diagnosis, and it has been in this latter connection that the autopsy findings are most enlightening; the following remarks are based upon examinations of patients before and after operations and at autopsies disclosing occasionally a tumor formation only suspected on account of the increased intracranial pressure, but more frequently no tumor at all, and yet all the symptoms and even the localizing signs of brain tumor were present—a “wet,” swollen, œdematous brain being the usual operative or post-mortem finding. In these latter patients, the walls of the supracortical veins and occasionally of the Pacchionian vessels as well as of the sinuses themselves were usually thickened and indurated and the delicate vessels lying in the sulci upon the cerebral cortex presented a cloudy, hazy appearance due to connective-tissue formation resulting from either a former meningoencephalitis of mild degree or a layer of supracortical hemorrhage—the residue after absorption being sufficient in these patients to block partially the little stomata of exit of the cerebrospinal fluid in the walls of the supracortical veins so that a “wet,” “waterlogged,” œdematous condition of the brain occurred—in reality, a secondary external hydrocephalus of varying degree and thus simulating by the resulting symptoms and signs the condition of brain tumor; if apparent localizing signs of a more œdematous area of the brain appeared, then the localizing signs of a “brain tumor.” These so-called pseudo-tumors are not only capable of producing all of the cardinal general symptoms and signs of a brain tumor, but even in their extreme degree—severe headache with vomiting, “choked disks” of even six diopters with resulting secondary optic atrophy and also in a large percentage of these patients localizing signs indicative of the exact site of the supposed tumor.

Treatment.—In the treatment of these patients having the condition of suspected brain tumor and associated with a marked increase of the intracranial pressure, and yet in the absence of definite localiz-

ing signs, there should be no prolonged delay in advising the operative lowering of this increased pressure by means of a decompression; if a subtentorial lesion can be excluded—and these posterior basal tumors just as cerebellar abscesses, are usually more easily diagnosed than supratentorial ones, then the subtemporal decompression⁴ and exploration is the most satisfactory method of lessening the increased intracranial pressure and, if considered advisable, of exploring the ipsilateral cerebral hemisphere in search of the tumor by means of a *blunt* exploring needle, such as the usual ventricular puncture needle; (the use of a sharp exploring needle and its attachment to a suction-syringe into which brain tissue is readily drawn may be interesting pathologically, but of no value to the patient, and this technic should be limited to work upon the cadaver); at the same time, the lateral ventricle may be safely tapped and its permanent drainage instituted by means of the linen strands. In unmistakable subtentorial and cerebellar tumors, naturally the ideal method of approach is through the suboccipital arca—a bilateral exposure being always advisable in order to facilitate the removal of the tumor with the least operative damage.

It is, however, in those suspected tumors of the supratentorial cerebral hemispheres with apparently definite localizing signs and in the presence of a high intracranial pressure as indicated by the “choking” of the optic disks—it is in these patients that operative catastrophes are most common, and especially if the clinical signs are indicative of a lesion of either motor area. The surgical approach has usually been through an osteoplastic “flap” operation—the “turning-down” of an area of the vault overlying the supposed site of the cerebral tumor; even if the tumor is found as diagnosed, yet its removal through this opening in the presence of a high intracranial pressure sufficient to bulge the exposed cerebral cortex into the bony opening is accompanied in a large percentage of the patients by grave damage to these delicate cortical cells, and if the tumor should not be found—and unfortunately this is an only too common occurrence, then it is practically impossible to suture the incised dura over the tense and bulging cortex without most serious cerebral damage and even cell destruction; at times, it is impossible to close the dural opening owing to the herniating cortex so that either the bone-flap is re-

⁴*Amer. Jour. Med. Sci.*, April, 1915, No. 4, vol. cxlix, p. 563.

placed with difficulty and with a varying degree of compression upon the underlying exposed cortex or the bone-flap itself must be removed so that merely the overlying scalp is sutured above the protruding brain substance. In patients having only a moderate increase of the intracranial pressure, this method may be used with little or no immediate cell damage, but even in these patients if a growing irremovable tumor is present, then this operative area will gradually bulge, signs of direct cortical compression by the overlying bone-flap will appear, necessitating an operative removal of this area of bone and then in the absence of the bone-flap, there develops the bane of cranial surgery—a hernial protrusion and, as the intracranial pressure increases, a probable fungus formation until months later, a localized meningitis becomes the forerunner of the terminal stage of the vegetative existence. These are the impressions transmitted from an earlier era of cranial surgery and occasionally still practiced, when it was the rule and not the exception, as now, for these patients to be worse following the cranial operation than before it was performed and it is this remembrance by the older men in the profession which has almost discredited a rational cerebral surgery of the present day. And again, in those patients having a high intracranial pressure in whom a tumor is found and even removed, the immediate operative damage to the adjacent cortical cells is great, and if the tumor is a malignant one—and seven out of ten are—then the post-operative progress is similar to the foregoing picture—cerebral hernia, fungus, death; in the presence of malignancy, however, the operative conscience is assuaged. But if no tumor is found and no tumor is present—merely the “wet,” œdematous cortex of secondary external hydrocephalus resulting from a partial blockage of the excretion of the cerebrospinal fluid into the supracortical veins but under high pressure, then the immediate operative damage to the cortical cells underlying the osteoplastic exposure of the vault is the same as above—and no tumor present, merely a “wet,” œdematous brain. These are the patients to be treated much more rationally by means of a preliminary subtemporal decompression over the cerebral hemisphere the more suspected, and then, if a tumor is located by the exploratory punctures (and the entire hemisphere can be safely explored through this opening), it can be removed by an osteoplastic operation directly over the tumor site within a period of one week or ten days and with little or no danger of damage to the

adjacent cerebral cells owing to the former lowering of the intracranial pressure. And if no tumor can be located by means of the preliminary subtemporal decompression and a tumor is present, then the localizing signs of its presence may develop later and thus permit its removal, and yet the patient during this waiting-period has been comparatively comfortable and has not become blind and irreparably impaired mentally and physically, inasmuch as the subtemporal decompression has provided an operative lowering and retardation of the increasing intracranial pressure by a limited bulging and pulsation of the overlying temporal muscle; if necessary, a bilateral subtemporal decompression may be performed at a later period, as indicated by the increasing height of the intracranial pressure, and in this manner the pressure damage to the cerebral cortex is retarded in the hope that a removable tumor will localize itself. But (and fortunately the following condition is being recognized more and more frequently), if at the time of the subtemporal decompression and exploration no tumor is found, and in addition to this negative finding there is revealed a swollen "wet," œdematous brain in the presence of a cloudy, hazy induration of the walls of the supracortical veins and thus a demonstrable cause for the partial blockage of the normal excretion of the cerebrospinal fluid into these main "absorptive" channels—it is in these patients that frequently a subtemporal decompression and drainage of this blocked cerebrospinal fluid is sufficient to permit an excellent recovery of life and normal function to be obtained; in several of my patients in this series of cases it has been necessary to perform a bilateral decompression in order to permit a greater lessening of the increased intracranial pressure by a more profuse drainage.

The subtemporal decompression and drainage in these patients is the ideal route and method on account of its exposure of a less highly developed area of the cerebral cortex and therefore any operative damage does not appear clinically, its exposure permits a careful exploration of the entire cerebral hemisphere, and even tumor growths of the adjoining brain tissue may be removed through it, and then of the greatest importance, not only can efficient drainage of the blocked cerebrospinal fluid be obtained and thus a continued lowering of the increased intracranial pressure, but the firm closure of the overlying temporal muscle and fascia prevents any excessive bulging of the

operative area and in this manner practically eliminates the fear that a herniating fungoid mass will develop. It is, therefore, on account of the foregoing reasons that I believe that the subtemporal operation is the ideal method of decompression and of approach to all supratentorial conditions producing a high intracranial pressure—especially if there are no localizing signs, and also even in the presence of localizing signs indicating a definite area of the cerebral cortex and yet when it is not absolutely certain that a removable lesion is there situated; only too frequently a removable lesion is not present at the site apparently indicated and the operative risk and damage may be tremendous—even more than from the lesion itself; if these unfortunates cannot be helped by an operation, by no means make their condition worse. On the other hand, if the signs indicative of the site of the tumor are confirmed by means of the preliminary ipsilateral subtemporal decompression, then the tumor can be removed at a later operation with the minimum amount of cerebral damage, and if a tumor is not present, the patient has undergone an operative risk of life of less than 10 per cent. and of no real danger of operative damage—with the advantage of an opportunity to recover from a non-tumor condition.

CLINICAL REMARKS ON FACIAL PALSY AND ITS TREATMENT BY NERVE ANASTOMOSIS

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THE question of the bulbar nucleus of the facial nerve—a subject of utmost importance for the interpretation of surgical anastomoses of this nerve—has been one of the most discussed in anatomy. Frequently modified by physiological and clinical data obtained as progress in these branches continued, the presence of the seventh cranial pair has been admitted with precision founded on recent pathological findings.

Louget placed the origin of the facial nerve in the lateral fasciculus of the bulb, while Stilling supposed that the facial and external oculomotor nerves had a common nucleus. Duchène, of Boulogne, in order to explain labioglossolaryngeal paralysis which did not involve the upper muscles of the face, described two bulbar nuclei for the seventh pair; an upper one in common with motor nucleus of the eye, corresponding to the upper intact facial, the second and lower one, common with the hypoglossus and representing the lower paralyzed facial nerve.

Mathias Duval maintained that there was a single facial nucleus—the lower one—quite distinct from the nucleus of mastication, but he also supposed that in its course around the eminentia teres, the seventh pair received filaments from the nucleus of the external oculomotor nerve.

From his work on rabbits, Mendel concluded that the upper muscles of the face were innervated by fibres originating in the posterior portion of the nucleus of the common oculomotor nerve.

The exhaustive researches of Marinesco on dogs, cats, guinea-pigs and rabbits resulted in definitely locating the origin of the superior facial nerve in the dorsal portion of the inferior nucleus of the facial, and he consequently attributed a single nucleus to the seventh pair, it in turn being divided into three more or less distinct cellular groups.

Van Gehuchten, in studying the phenomena of chromatolysis in rabbits, confirmed the findings of Marinesco in respect to the nucleus of the facial nerve.

But unquestionable proof of this bulbar localization of the seventh pair has been lately given by the pathological researches of Parhon and his co-workers. By Nissl's Technique he endeavored to locate the nucleus of the facial in a case of cancer situated in the subhyoid region and which had invaded the muscles of the lower region of the face, and afterwards in another case of epithelioma, situated on the course of the superior facial nerve, which resulted in degeneration of the frontal and levator palpebræ superioris. Parhon was able to complete and confirm Marinesco's findings.

From these conclusions it is to-day admitted beyond doubt that the bulbar nucleus of the seventh pair is represented by a single nucleus belonging to gray column which represents the anterior horns in the protuberance. This nucleus is situated at the antero-external and inferior portion of the protuberance, between the nucleus ambiguus and that of mastication, the former below, the latter above it, to the outer side of the fasciculus of the external oculomotor and on the inner aspect of the roots of the trigeminus nerve. This nucleus, the sole origin of both the superior and inferior facial nerve, is composed of groups of cells, circumscribed and distinct from each other, which recent researches have divided into three groups, namely, an internal, an anterior and a posterior or dorsal group. It is in the dorsal growth of cells that the fibres of the facial, destined for the upper muscles of the face, take their origin.

These researches have even revealed in the midst of this nucleus and in the small secondary groups which there exist, the representation of special muscular territories. Although as yet incomplete, these findings lead one to assume that further pathological work will finally definitely determine the place occupied by the cells governing the movement of each muscle of the face. Logic leads me to this conclusion. Since the electric experiments of Hensen and Volckers, completed as they are by the work of Bernheimer, it is now classic to subdivide the nucleus of the third pair of cranial nerves into specialized cell groups. Van Guehuchten has likewise shown that the nucleus of the sixth pair is divisible. Parhon and Goldstein, after having localized the origin of the descending branch of the hypo-

glossus in a dorsal cell-group, describe subdivisions in this nucleus corresponding to muscular localizations.

For that matter, there is a decided tendency to admit that the nuclei of the cranial nerves are submitted to the same laws which determine localization of the medullary nerves. The French school admits the theory of muscular function maintained by Sano, according to which each muscle has its special centre, but these centres are arranged like the muscles themselves, and this appears to me to fit in better with the data obtained from clinical observation, especially evident in cases of anterior polyomyelitis.

Leaving the nucleus just described, the fibres of the facial nerve are directed backwards and downwards, and then forming a bend they descend longitudinally into the floor of the fourth ventricle, between the eminentia teres and the median raphe, and then, after making another bend, they are directed forward and outwardly, emerging from under the protuberance at the level of the supra-olivary fossa.

From its point of emergence from the bulb the facial nerve runs forward, outward and upward toward the internal auditory canal into which it penetrates in company with the eighth pair and Wrisberg's *nervus intermedius*. Then, at the bottom of the canal it enters the aqueduct of Fallopius, travelling throughout its entire extent, finally to make its exit from the cranial cavity through the stylo-mastoid foramen.

During its intrapetrosal course, the facial nerve naturally follows the inflexions of the osseous canal through which it passes. It is therefore divided by two bends—the first called the genu—into three segments. The first segment is directed forwards and outwardly, the second backwards and outwardly, the third segment being directed vertically downwards.

After its exit from the mastoid foramen, the facial nerve takes a downward course forward and outward for the distance of twelve to fifteen millimetres, and then bending slightly upward it reaches the posterior border of the parotid gland into which it penetrates. In this short course the nerve twines round the base of the styloid apophysis and always at the outer aspect of the large vessels of the neck it crosses the posterior auricular artery, and before becoming engaged in the parotid at a point near the external border of the external jugular, it divides into two branches, the temporo-facial and cervico-facial.

In traversing the parotid gland from behind forwards and in the midst of its parenchyma, these two branches become subdivided into a large number of branches which go to all the muscles of the face.

From the viewpoint of particular interest to us, these simple anatomical data of the facial nerve are sufficient, while a brief outline of the physiology will impart the necessary information in respect to its collateral branches. Since Meckel's researches the movements of the face have been attributed to the fifth and seventh cranial pairs. It was only from 1831 on, following the remarkable researches of Sir Charles Bell, that it was generally admitted that following division of the facial nerve, the sensibility of the face remained intact, the movements alone being abolished.

Magendi's experiments completed the researches of the great English physiologist and since then the true functions of the facial nerve have been known.

The facial is the motor nerve of the face. It holds the contraction of the superficial muscles of the face under its dependence, to which must be added those of the scalp and neck. It also innervates the posterior belly of the digastric stylohyoid, styloglossus glossostaphalin and the muscle of the stapes. The part played by the facial in relation to these muscles has been clearly demonstrated by both electric and mechanical excitation, as well as by clinical data of human pathology.

Presiding over the movements of the facial muscles, the facial nerve is essentially the nerve of physiognomy, so that when it is paralyzed on both sides the patient cannot impart his feelings by expression. The face looks as if hidden by a mask under which the ocular globes alone have preserved their motility.

In unilateral paralysis, the paralyzed side has become a stranger to both expression and mimicry. The two sides of the face are asymmetrical even in repose, the features on the normal side are drawn by the muscular tonicity which has no counterweight from the paralyzed side. The cutaneous folds are effaced on the paralyzed side, the commissure of the lips is drawn upward on the normal side and lowered on the paralyzed side. In typical cases the displacement of the features is such that the paralyzed side is immovable and projecting, while the normal expressive half of the face appears as if sunken.

But this plastic functional part played by the seventh pair is not

the only one. From the great number of small muscles innervated by it this nerve in a roundabout way exercises a very important influence over the organs of sense, either by protecting them or by facilitating the exercise of their functions. "To each sense is annexed a tiny muscular apparatus, and when stimulations other than those related to this particular sense arise the muscular apparatus entrusted with its protection immediately intervenes for preventing their entrance, while if the special stimulants of these senses act with too great intensity this apparatus interferes by moderating their action. If on the other hand, this action is too weak, this apparatus again interferes, but with an opposite end to be attained" (Sappey).

By its ramifications ending in the orbicularis, the facial nerve controls the movements of the upper lid, and when it is paralyzed the lid can no longer close, complete winking becomes impossible and the lids are almost immovable.

Paralysis of the orbicularis, accompanied by that of Horner's muscle—the tensor tarsi—likewise innervated by the facial, has lachrymation as a consequence. There results a defective mechanical propulsive action caused by continual blinking, the lachrymal orifice becomes extroverted, the lachrymal sac no longer dilates, so that the tears can no longer follow their normal excretory route. The protective action, normally exercised by the lid over the conjunctiva, is likewise abolished.

The action of the facial nerve on the auditory apparatus should be a double one were it not for the fact that one of these influences is practically *nil* in man because, given the rudimentary state of the muscles the concha of the ear, the nerve is incapable of directing it in the direction to completely catch sound-waves. In certain subjects, however, who possess the faculty of moving the auricle of the ear, these movements are abolished when the facial nerve is paralyzed.

Of much greater importance is the action of the facial nerve on audition strictly speaking. This nerve innervates the stapes by a tiny ramification, which is given off by the facial during the second part of its intrapetrous course, a little above the geniculate ganglion.

The part played by this tiny muscle of the stapes appears to have been badly interpreted until within the last few years, and Gley, in his "Traité de Physiologie," published only ten years ago, states that its action is imperfectly understood. In fact, some observers attribute

to it the function of relaxing the tympanum while others suppose that its action consists in contraction which prevents or moderates the amplitude of the movements of penetration of the stapes into the fenestra ovale.

Professor Bard, until recently professor of clinical medicine at the University of Geneva, by his numerous papers on audition, the principal ones having been published in the *Journal de Physiologie et Pathologie Générale*, 1904 and 1905, was the first to enlighten the question of the faculty of auditive accommodation to distance and gave a more exact interpretation of the part played by the muscle of the stapes, an interpretation which tallies better with the data obtained by clinical observation. According to this interesting theory—the details of which I cannot enter into at present—the muscle of the stapes should have a very definite action. “It draws the neck of the stapes and with it the entire chain of ossicles and handle of the malleus backward, in such a way that it puts the anterior half of the tympanum on the stretch; it thus produces unequal tension between the two vertical halves of the membranes, whose adjustment adapts the tympanum to the distance occupied by the source of the sound specially listened for.”

As Bard has himself remarked, the insertion of the tendon of the muscle of the stapes being on dead point of the tilting movement of the plate of the stapes commanded by the thrusts coming from the hook of the incus, the physiological contractions of this muscle may be effected without interfering with the action of the muscle of the malleus or other modalities of movement of the chain of ossicles.

The muscle of the stapes is consequently not antagonistic to the muscle of the malleus, “their contraction may be isolated or synergistic, according to the requirements of the function, the action of each being special and autonomous, independent of that of its congener, but susceptible of combining or not with it”

The muscle of the stapes therefore having for function accommodation for distance, playing in audition a part similar to that of the ciliary muscle in the functions of sight, is destined to adapt the ear to the audition of close sounds and consequently it can be readily understood that in case of paralysis very marked disturbances will ensue to which I shall refer later on.

The action of the facial nerves on the olfactory apparatus,

although less, is nevertheless very evident. By its nasal branches the seventh pair governs the movement of the myrtiform and triangular muscles of the nose, the *dilatores nasi*, *levatores* of the *alæ nasi* and the levator common to the *ala nasi* and upper lip.

The importance especially of the last-named muscles, which are distinct dilators is very evident. Not only do the nostrils dilate slightly during normal inspiration, but especially during the action of smelling. In case of paralysis of these muscles it is evident that very accentuated disturbances of smell will be manifest. The action of the facial nerve on the secretion of the nasal mucosa must also be included among its functions in the apparatus of olfaction.

The part played by the seventh pair in the digestive functions of the tongue is still more marked.

I shall not refer to the physiology or anatomy of the tympanic cord, and although this subject is of great interest, it is still obscure, and the hypotheses that have been emitted have each in turn been contradicted. In fact, physiologists have proposed various theories to explain the part played by the facial nerve, or more correctly, the cord of the tympanum in taste, and I cannot do better than to give the summary of these different systems as outlined by the late Professor Grasset, of Montpellier.

1. In the first system, the facial nerve has an indirect motor action on the taste; this is Claude Bernard's theory.

2. In a second system the trigeminus is the gustatory nerve of the anterior portion of the tongue. Among the partisans of this theory, some suppose that the impression passes directly by the lingual and trigeminus (Rouget); others by the lingual, tympanic cord and the greater superficial petrous nerve (Schiff); others by the lingual, tympanic cord and peripheral part of the facial and trigeminus (Stich); and lastly, others do not offer any precise course (Vulpian).

3. The third system supposes a special gustatory nerve distinct from the facial and trigeminus, situated in the anterior portion of the tongue, namely, the glossopharyngeal and Wrisberg's nerve (Mathias Duval).

It is therefore evident that the important question of the origin of the tympanic cord which has defied the sagacity of anatomists to the present time, has not been given a final interpretation by physiologists so that in the present state of our knowledge we are compelled to be

content with clinical data which, be it said, are not themselves much more precise.

But by its ramifications which preside over the orbicularis of the lips and muscles whose function is opening of the buccal orifice, the facial nerve plays a very important part, not only in prehension but above all in mastication. The cheek, composed almost entirely by the buccinator muscle, completes the part played by the lips in the first act of digestion of food. The cheeks and lips have as function to retain the food under the dental arches during mastication by their simple tonus and to help collect it on the dorsal aspect of the tongue.

Closing of the lips, obtained by simple tonicity of the orbicularis, prevents the saliva from flowing out.

Deglutition is also partially under the control of the seventh cranial pair, because by its ramifications going to the posterior belly of the digastric and stylomastoid, this nerve produces an elevation of the base of the tongue and therefore helps in closing the isthmus of the fauces.

The influence of the facial nerve on the velum palatinum appears at present to be admitted by the majority of clinicians and many physiologists. The classic text-books on anatomy still describe the facial nerve, sending ramifications to the internal staphylinus and staphylinus medius. It would seem that Louget is responsible for this mistake which has been handed down during the past sixty years. Reid, who was the first to undertake physiological experiments on the subject, denies that the facial has any action on the velum palatinum, but the more recent experiments of Chauveau, Beevor and Horsley are positive in this respect, namely, that stimulation of the facial before it enters the internal auditory canal, does not provoke any contraction of the velum.

Finally, the facial contains some sensitive fibres, but of course they do not belong to the seventh pair. It is a borrowed sensibility from the ramifications which the vagus sends off to the facial in the jugular fossa, as admitted by J. Müller and confirmed by Claude Bernard, as well as a recurrent sensibility coming to it by means of the terminal ramifications of the trigeminus, as has been demonstrated by Arloing and Trippier.

Facial palsy is certainly one of the most frequent paralysees met with in practice. The long and very uneven course of the seventh

cranial pair, its close proximity to the middle ear, the small diameter of the osseous canal offered by the petrous portion of the temporal bone are the evident reasons for the very frequent occurrence of this affection.

As in the case of all paralyses, it is classic to accord two different origins to facial palsy, namely, a cerebral and a peripheral one. The paralysis is peripheral when the lesion involves the bulbar nucleus or the nerve itself below the nucleus.

This distinction is very important because, although some disturbances in the muscles innervated by the seventh pair when the paralysis is of central origin, trophic disturbances are not met with since the bulbar nucleus is not involved in the lesion. There is no reaction of degeneration.

Besides the signs furnished by electric examination, it is classic to admit that in facial palsy of central origin the upper branch of the nerve is not involved in the paralysis. When considering Revilliod's sign, I shall refer to the restrictions that can be rightly made regarding this subject, but right here I would point out that the automatic winking, preserved in paralysis of central origin, is likewise preserved to a great degree in the peripheral variety of the process. In fact, I have always noted that in cases where no voluntary movement of the upper lid was possible regardless of the great effort on the patient's part—following complete division of the nerve—the movements of winking were distinctly manifested by a slight and sudden dropping of the upper lid, partial, it is true, because it does not come into contact with the lower lid, still it is very easily perceived.

These movements, synchronous with the winking of the intact eyelid on the opposite side, oblige us to admit, as Professor Sahli, of Berne, believes, that the automatic winking is not merely due to contraction of the orbicularis muscle, but that it is function also of a certain degree of relaxation of the levator muscle of the upper lid.

The emotive movements likewise persist in facial palsy of central origin, but I merely mention this phenomenon because its explanation is based upon interpretations quite as varied as they are hypothetical.

From the surgical standpoint only facial paralysis of peripheral origin need only be considered. The etiology is most variable. The ancient physicians, who knew the symptomatology of facial palsy,

never could attribute it to its true cause; but Aretaeus of Cappadocia * refers to six distinct etiologies, namely, *vulnus*, *ictus*, *frigus*, *cruditus*, *venus*, *violentia*.

At its entrance into the skull the nerve may be compressed by all kinds of neoplasms, by a localized meningitis or a syphilitic gumma. During its course in the petrous portion of the temporal bone the nerve can be injured by a great many factors; fractures of the skull, in which the petrous portion of the temporal bone so frequently participate, are frequent causes of lesions of this nerve.

Tumors of the auditory nerve, which accompanies the seventh cranial nerve during the first part of its course, may, by compression or extension, cause facial paralysis. The facial nerve being accompanied by the stylomastoid artery in the aqueduct of Fallopius, which forms anastomoses with other vessels of the cavity of the tympanum, it can readily be conceived how a pathologic process of this artery—congestion, hemorrhage, aneurism, etc.—may act in a nefarious way on the nerve. A very typical example has been recorded by Bienfait in the *Journal de Neurologie*, 1904.

But it is its close proximity to the middle ear that the great vulnerability of this nerve is due. The aqueduct of Fallopius forms part of the wall of the middle ear and is only separated from it by a thin lamella of bone, which itself is often riddled with apertures. It can be readily understood that all the common affections of this cavity—acute or chronic otorrhœa or simple catarrhal otitis—may become complicated by facial palsy. In a study on necrosis of the labyrinth, Bezold found facial paralysis in 83 per cent. of the cases.

This close proximity of the seventh cranial nerve to the different cavities of the ear make this nerve one of the most formidable perils in operations on the external ear, middle ear and labyrinth. But it is more particularly in mastoid operations that the nerve is the most exposed to injury, and in spite of the technical rules laid down by modern operators, anomalies are frequent, and many a facial palsy is the outcome of an unfortunate manœuvre with the chisel.

Besides these direct operative injuries to the nerve which are true operative paralyses, there are other palsies which do not arise

* From notes of the lectures on the history of medicine delivered at the University of Geneva by Professor Cumston, who points out that four of the etiological factors given by Aretæus are admitted in modern pathology.

at once, sometimes only developing several days after the operation, and which may be qualified as post-operative paralysis. These are due to various causes, are often noted at the change of dressings, and although neuritis of perineuritis is the cause in not a few cases, a dressing too tightly applied, a too energetic cauterization or an awkward curettement are occasionally responsible for the process.

In its short course after leaving the skull, the seventh cranial nerve is sometimes injured by the knife seeking a lymph-node situated high up, especially in the case of the lower branch of the nerve, several striking examples of which have been published by Polosson. The nerve may also be injured by slight slip of the periosteal elevator when decorticating the periosteum from the tip of the mastoid apophysis.

During its intraparotid course the seventh cranial nerve will rarely escape the morbid influences resulting from disease of this salivary gland.

Certain neuropathic predispositions brought forward by Neumann are susceptible of contributing cases of peripheral facial palsy. Charcot long since drew attention to this etiology and mentioned two Jewish families, in one of which two brothers and a sister were afflicted with facial paralysis. In the other three sisters had had peripheral facial palsy. The eldest sister married her daughter to the son of the second sister; he became ataxic and presented a facial palsy from which he recovered. A daughter issued from this marriage had scarlet fever at the age of fourteen, and following this she developed chorea, and later on facial palsy. Such facts require no comment as the influence of similar heredity is only too evident.

But by far the largest number of cases of paralysis of the seventh cranial nerve are the result of some unknown factor. Bérard attributed them to a congestion of the nerve from exposure to cold. This etiology was further developed by Erb and the term of *paralysis a frigore* is still used to-day for cataloguing the majority of cases of this affection.

A certain number of these paralyses, also called *rheumatic*, seem, however, to have an otic origin. Dejerine and Theolari attribute a neuritic nature of unknown cause to these *a frigore* cases, while Mirallie has recently confirmed this pathogenesis by the autopsy of a case of this type of palsy, and Minkowski, in still another case, found the nerve fibres degenerated but without inflammation of the neurilemma.

As is the case for all other nerves, the facial may become paralyzed during the evolution of various infectious diseases, and although the mechanism of their action is not distinct, examples of this affection are not uncommon following diphtheria, influenza, pneumonia, scarlet fever, typhus and tetanus, and Le Quinquin in his thesis (Bordeaux, 1890) refers to a real epidemic of paralysis of the seventh nerve following multiple infections.

Facial paralysis due to syphilis may be early or late in appearance and have been well studied by Dieulafoy. They are relatively frequent, and Fournier as far back as 1873 stated that "of the secondary syphilitic paralyses facial hemiplegia is by far the most common."

In 1907, Fuchs took up the question of etiology based on nearly six hundred cases of facial paralysis at the Clinic of Nervous Diseases at the University of Vienna, with the following results: Forty-three cases had an otic origin, seventeen were traumatic, fourteen were syphilitic, eleven congenital, eight were associated with paralysis of other cranial nerves and in five hundred the etiology could not be ascertained.

Sex does not appear to exert much of any influence, and in Fuchs' statistics there were 308 males and 285 females. On the other hand, the seasons seem to have some influence in the production of this paralysis, the larger number of cases being observed in September, according to Fuchs.

Sir Charles Bell was the first to describe this paralysis—in 1853—hence the name of Bell's palsy given to it by Graves. Giving off collateral branches and receiving anastomoses from other nerve trunks along its course, the seventh cranial nerve has not the same anatomical make-up throughout its length, and therefore the consequences resulting from its paralysis are variable according to the location of the lesion.

Let us first consider the most frequent variety called furnicular paralysis in which the nerve is involved after it has made its exit from the skull. As a consequence, there is complete paralysis of the entire corresponding side of the face. The muscles not only lose their voluntary mobility, but also their normal tonicity, and as a consequence of this break in muscular equilibrium of the two halves of the face, asymmetry ensues.

The furrows and folds of the skin of the face and forehead become

effaced on the paralyzed side, and according to the witty expression of Romberg, "facial paralysis is the best of all cosmetics for causing the wrinkles of advancing years to disappear."

As a consequence of paralysis of the orbicularis muscle of the lips, the subject cannot whisper or whistle. The pronunciation of the labial letters, especially P and B, is defective or impossible; the saliva flows away through the labial commissure on the affected side. Food accumulates between the cheek and teeth, the patient bites the cheek frequently on account of the lack of tonus of the buccinator muscle, while the cheek becomes passively distended at each expiration.

In children the act of sucking is greatly hindered. The involvements of deglutition are also involved, because on account of paralysis of the digastric and stylohyoid muscles, the rising of the base of the tongue—consequently the closing of the isthmus of the fauces—is interfered with.

The tip of the nose is slightly drawn to normal side; the ala of the nose no longer possesses voluntary movement, so that during inspiration it is passively drawn toward the nasal septum instead of spreading from it as it normally does. These disturbances—also accompanied by a certain degree of dryness of the nasal mucosa—produce a slight degree of anosmia which can always be detected in the nostril on the paralyzed side.

All movement of the auricle of the ear is abolished if any existed before the advent of the affection, but O. Berger observed a patient who was privileged in this respect and lost it during the evolution of a facial palsy.

The platysma muscle is also paralyzed—Babinski's sign—a condition easily made evident when the subject draws the lower lip forcibly downwards. The platysma on the normal side forms a normal relief.

The ocular disturbances are more accentuated. The patient cannot contract the eyebrow on the diseased side. Not only is there lagophthalmos, but the lid remains largely open. Epiphora provokes inflammation of the surrounding skin and eczema often ensues. These ocular disturbances are the cause of conjunctivitis, while keratitis from foreign bodies is frequent.

Speaking of paralysis of the eyelids in cases of peripheral facial hemiplegia, Jaboulay refers to three cases in which excision of the

parotid gland was followed by facial palsy but without any disturbance of the movement of the lids. Jaboulay very justly remarks that the prolongation of a motor muscle of the lids to the aponeurosis must of necessity open the lids, and he concludes: "The active closing of the palpebral opening is due to the orbicular muscle of the lids alone, so that it is unquestionable that this muscle is controlled by a force other than that derived from the facial nerve when the lid can still contract after paralysis of this nerve has occurred."

Relative to movements of the lid in peripheral paralysis of the seventh cranial nerve, Dupuy-Dutemps has brought forward a new phenomenon. When the patient looks downward, the upper lid closes at the same time that the globe of the eye turns downward, although it remains higher than the lid on the normal side. If, in this position the patient is requested to close the eyes, the lid on the affected side will rise notably above its former position.

This phenomenon is still more accentuated the more marked be the paralysis of the orbicularis, and Dupuy-Dutemps attributes this to the aponeurotic adhesions mentioned long since by Bérard, between the lids and ocular muscles. During energetic voluntary closing of the lids the globe rolls upwards and inwardly, drawing the upper lid along with it, whose orbicularis is paralyzed.

Besides these palpebral symptoms another ocular phenomenon is met with in facial hemiplegia that Bernhardt has baptized with the name of *Bell's sign*. The English physiologist was the first to remark that during occlusion of the lids the globe of the eye rotated upwards and outwardly. The cornea is directed upwards under the upper lid and the pupil becomes hidden to view. This phenomenon has been studied in facial hemiplegia by Bordier and Frenkel. These observers attribute it to the passage of a diffuse nervous influx between the facial and external oculomotor nerves by way of anastomoses which unite the two nerves according to Mendel's theory.

However, Bernhardt has established that this phenomenon is physiological as Sir Charles Bell maintained, because it can be observed during sleep, and he explains it by a preëstablished mechanical action due to anatomical connections. Therefore, this fact should constitute a symptom of peripheral facial palsy because, on account of the absence of contraction of the orbicularis muscle the lids remain open so that it becomes very apparent.

This explanation does not seem to me to be clinically satisfactory, because one can invariably note that this so-called *Bell's sign* undergoes an amelioration parallel with the improvement taking place in the facial paralysis itself. For that matter, it is all the more accentuated the more serious the paralysis.

The hypothesis offered by Sahli is more in keeping with these clinical data, namely, that on account of the paralysis of the facial nerve the effort made by the patient to close the lid remaining without result, radiates by other central associated tracts to the nerves of the motor muscles of the eye. This hypothesis seems to me to be all the more plausible, because it likewise suffices to explain the phenomenon described by Gifford by the name of oculopapillary reflex and which can also be observed in facial palsy. If the patient is told to close the paralyzed lid forcibly a contraction of the pupil will be observed. Consequently this reaction must be due to a very powerful stimulation of the lids directed to the orbicularis and remains without action, because it can be obtained in normal subjects by preventing closure of the lids.

The ocular symptoms that have been described are pathognomonic of peripheral facial palsy, because when the paralysis is of central origin the eye does not appear to be involved. However, in reality, in central lesions of the seventh cranial pair the eye is not completely untouched and the late Professor Revilliod, of Geneva, was the first to draw attention to this phenomenon. Under the term of the *sign of the orbicularis*, Revilliod, in 1889, expressed himself as follows: "If the patient be requested to close both eyes—in cases of hemiplegia—he will do so. He can also close the eye on the normal side, leaving the lid open on the paralyzed side; but it is impossible for him to execute an inverse order; that is to say, to close the lid on the paralyzed side, keeping the normal one open."

To explain this phenomenon, Rivilliod admitted a partial decussation of the seventh cranial nerve before reaching its bulbar nucleus.

I have now outlined the symptoms of facial palsy when the nerve is injured after it has made its exit from the skull, but when it is involved during its course through the petrous portion of the temporal bone other symptoms become added, and which result from a loss of function of various branches given off by the nerve during its course through the osseous canal. And since these branches are not all given

off at the same spot, but are sent off along its course, one can by a detailed examination of the symptoms offered by the paralysis localize the site of the lesion of the nerve in the aqueduct of Fallopius.

On account of the participation of the tympanic cord in intrapetrous lesions of the seventh cranial nerve, disturbances of taste will ensue as was first demonstrated by Claude Bernard, in 1843. The changes of the sense of taste are seated in the two anterior thirds of the tongue on the paralyzed side and consist of either abolition, a delay or perversion of taste. The sensibility is preserved in this territory of the tongue.

Such are the clinical observations that have been made on this subject, but it must be admitted that much uncertainty reigns in respect to these gustative disturbances in facial palsy. The subject, which has considerable clinical importance from the viewpoint of making an exact localization of the lesion involving the nerve, is nevertheless far from having been given any certitude or clearness on the part of physiologists which can serve as a basis for an attempt at precise diagnosis, and I am of Grasset's opinion when he says that "in the present state of our knowledge it would be imprudent to take them into serious consideration."

When the lesion is situated still higher up, the nerve muscle of the stapes will be compromised; this tiny muscle is consequently paralyzed and disturbances of hearing appear. Roux was the first to mention this phenomenon which he observed on himself. It took the form of painful vibrations of the membrana tympani, occurring during a facial palsy. In 1851, Landouzy, who undertook a complete study of this symptom which he called *hyperacusia*, attributed to paralysis of the muscle of the stapes. At present we know that this muscle is innervated, the masticating branch of the fifth cranial nerve, as Lannois has demonstrated. The auditory disturbances consequently result from paralysis of the muscle of the stapes, which effectively receives its motor nerve fibres from the facial only, as Lucal has shown.

The mechanism of the production of these disturbances of the hearing, as well as its clinical explanation, do not as yet appear to have been interpreted with sufficient correctness. Very varied opinions have been put toward explaining this phenomenon. Thus Gellé considers hyperacusia as a consequence of interstitial otitis

with chronic inflammation of the tympanum. Friedrich attributes it to a concomitant lesion of the nervus ancusticus on account of the close relationship of this nerve with facial. Tomka supposes that hyperacusia is due to a reaction on the labyrinth coming from the lesion in the canal of Fallopius that has caused the seventh cranial nerve to be paralyzed.

Besides these somewhat peculiar interpretations there is still another which is more generally accepted which attributes hyperacusia to a paralysis of the muscle of the stapes, having as a consequence a preponderating action of the muscle of the malleus, which thus being without a counterweight, transmits the vibrations of the tympanum too strongly to the fenestra ovale, thus shaking the fluid of the labyrinth too brutally.

From what I have said on the subject of the physiology of the muscle of the stapes and Professor Bard's theory, these auditory disturbances of facial palsy should be given quite a different interpretation. They are unquestionably due to paralysis of the muscle of the stapes, but this muscle having its own well-defined action and not a merely simple antagonistic action to the muscle of the malleus, the clinical manifestations of its paralysis should present a well-defined physiognomy.

On account of the paralysis of the muscle of the stapes the patient should lose the faculty of accommodation for distance which alone is the function of this muscle and as a clinical consequence, it should be impossible for him to accommodate his hearing when two persons speak to him at the same time so as to understand what one of them is saying, abstraction being made of what the other is telling him.

It can be understood that this faculty of following one sound that interests us more than others occurring at the same time must be badly interpreted by a subject with facial hemiparalysis, because the ear on the normal side to a certain extent replaces the paralyzed muscle of the stapes, so that the subject experiences a troubled sensation manifested by a disagreeable impression—or even distressing—of the hearing, which only a very close clinical analysis can attach to its true cause.

This phenomenon, to which great importance is attached for the localization of the site of the facial lesion, should nevertheless be carefully distinguished from another phenomenon occasionally observed

when the lesion is seated on the extra-petrous branches of the seventh cranial nerve. In these circumstances the patients frequently complain of tinnitus aurium when they attempt to contract the muscles of the face. This is merely an exaggeration of a phenomenon which can occur in normal subjects. Schwartz has shown that the voluntary impulse from the very fact that it can no longer impart the slightest movement to the paralyzed muscles radiates with greater intensity to those not involved and consequently to the muscle of the stapes which in normal conditions would remain inactive.

According to Koester, an inverse phenomenon may be observed in intra-petrous lesions of the facial nerve; that is to say, a diminution of the auditory acuity—a hypoacusia. In this case he attributes it to a lesion seated in the geniculate ganglion which sets up necrosis of the lower portion of the incus from which this ganglion is only separated by a thin bony lamella.

As to the secretory disturbances resulting from facial palsy, our knowledge is not precise, and physiologists are divided in opinion. As to the secretion of saliva Schiff demonstrated the hypercrinic action that the chorda tympani exercised on salivation produced by the submaxillary gland, and Claude Bernard completed these experiments. Carl, who had a perforation of the membrana tympani could, by stimulating his chorda, provoke salivary secretion on himself. Therefore, when the lesion of the facial is seated above the emission of the chorda tympani there should be a suppression of the saliva and generally such is the case. The patient complains of some dryness of the mouth on the paralyzed side, but this phenomenon is far from being a constant symptom.

Lachrymal disturbances in paralysis of the seventh cranial nerve have been referred to by several observers after Goldzieher had drawn attention to the subject in 1893. In this respect it should be remarked that when the lesion attacks the nerve above the geniculate ganglion, the normal eye is the only seat of lachrymation under emotional influences or reflex stimulation, while the eye on the paralyzed side remains completely dry. A distinction should also be made between the normal moisture produced by the secretion of the special glands present in the conjunctiva and the abundant production of tears which alone is due to the secretion of the lachrymal glands, these being under

the control of the facial nerve. Jendrassik has more recently confirmed these views.

The sudoral secretion has been studied by Strauss, who by injections of pilocarpin noted a delay of one to two minutes in the appearance of sweat on the paralyzed side in the serious forms of peripheral paralysis of the seventh pair and he even proposed this test in order to distinguish central paralysis from peripheral palsy because in the former there is no delay.

These results do not seem to have been confirmed by other observers, although Sahli states that Koester admits that disturbances of sudation do occur in facial palsy.

Very painful neuralgias have been met with in cases of peripheral paralysis of the seventh cranial nerve, and Weber appears to have been the first to study this symptom as far back as 1878. He states that he found it in 50 per cent. of the cases of facial palsy examined by him. Testaz, in 1887, described what he called *painful paralysis of the seventh nerve* and believed that the severity of the pain was in direct relation to gravity of the paralysis, a datum which does not appear to have been confirmed. Dieulafoy explained this phenomenon—frequent in syphilitic paralyses—by considering the facial as a mixed nerve, Wrisberg's *nervus intermedius* representing the sensitive branch, according to Mathias Duval's conception. It would be, perhaps, more correct to admit an extension of the neuritic process of the seventh cranial nerve to the recurrent branches of the trigeminus contained in the facial or to the anastomotic branches sent to it by the pneumogastric. This was Weber's opinion, and he drew attention to the localization of the pain which is particularly marked behind the ear—along the auricular branch of the pneumogastric or along the course of the inferior maxillary nerve branches of the trigeminus.

The position of the tongue in facial palsy has been much discussed, some observers stating that there is a deviation of the organ towards the normal side, others remarking the contrary. It is evident that when the facial is involved at its nucleus or in its intrabulbar portion by a concomitant lesion of the hypoglossus, there should be a deviation of the tongue, but a facial palsy *alone* cannot provoke any change in the position of the organ.

If in a case of facial palsy the patient protrudes the tongue and the organ appears to be deviated towards the affected side this is

merely apparent; the entire mouth being drawn towards the normal side, the tongue maintaining its median position becomes nearer to the labial commissure on the paralyzed side, a fact that can be proven by reducing the lips on the paralyzed side so as to give the mouth its normal aspect. In some rare cases of long-standing facial palsy a tendency of the tongue to approach the labial commissure on the normal side has been noted, but this is due to the fact that the patient having become used to his paralysis, he instinctively tries to hold the tongue in its normal relations to the labial commissures and in these circumstances if the mouth be placed in its normal position the tongue is carried directly forward in the median axis of the body, without deviation.

Disturbances of the soft palate consist of a slight dropping on the diseased side, although this does not cause any serious trouble because the reflux of liquids by the nostrils only occurs when the paralysis of the velum is bilateral. Recent physiological researches show that the facial nerve has no part in the movements of the soft palate and clinical observations bear this out.

Lermoyez points out that although changes in the soft palate have been observed in facial palsy, it was because there was a concomitant lesion of other cranial nerves—the spinal and pneumogastric. He mentions cases of paralysis of the recurrent nerve, associated paralyses of the soft palate and larynx, complicated by either paralysis of the trapezius and sternomastoid muscles, or with hemiplegia of the tongue.

When the singular *tortura faciei* resulting in facial palsy has once become established the question arises as to what shall be its evolution and, therefore, what is the prognosis and treatment. The evolution of facial palsy will evidently depend greatly on its etiology and can generally be determined by an electro-prognosis. In normal conditions muscles stimulated by a galvanic current provoke maximum contraction at the time the current is shut off at the negative pole. The reaction of degeneration is a change in electrical excitability characterized by a decrease or loss of faradic or galvanic excitability of the nerve and faradic excitability of the muscle, while it also retains its galvanic excitability, which may be even increased. As a qualitative change the reaction of degeneration is characteristic because the muscular contraction obtained by closing the positive pole is equal or even stronger than that of the negative pole, while the contractions

are slower and sluggish instead of being rapid. According to the data obtained by electric examination, it is now the custom to divide facial palsy into three categories as follows:

1. *Slight*, in which no change in the galvanic or faradic excitability of nerve or muscle is present. These are the most favorable cases, the prognosis is good and recovery usually ensues in about three to five weeks.

2. *Medium*. These are intermediary transitional forms offering manifest electrical changes, but without a complete reaction of degeneration. The muscular phenomena are certainly those of this reaction, but excitability of the nerve does not entirely disappear; it is only decreased for both kinds of current. This change in the excitability of the nerve appears very quickly, and being of short duration, may present a very marked contrast with the muscular excitability in this medium form of facial palsy. When directly stimulated the muscle contracts slowly, while contraction to the positive pole is stronger than to the negative. Indirectly stimulated by the intermediary of the nerve contraction is rapid and instantaneous, and is also stronger at the negative than at the positive pole. The prognosis is in general favorable, the paralysis requiring from six weeks to two months to disappear.

3. *Serious*. In this category all the typical phenomena of the reaction of degeneration are present. The prognosis is essentially bad, or at least very unfavorable, because the return of the functions in the most fortunate cases requires six months or more.

According to Onimus, traumatic facial palsy can be distinguished from the rheumatic type by electric examination. In the latter the electric changes arise much earlier and can be noted in a few days after the development of the symptoms.

This classification of facial palsies, based on electro-prognosis, although interesting and correct in the majority of cases, may nevertheless cause erroneous results, because the electric reactions do not always follow the physiological functions. Charcot reported cases of paralysis, accompanied by serious electric disturbances, which recovered rapidly, while others which appeared to be mild, according to results obtained by electric tests, required a long time to be recovered from. Brenner has also had similar experiences, therefore it is well not to pin too much faith on electro-prognosis.

Given a case of undoubted peripheral facial palsy, how should it be treated?

It is evident that the etiology of the given case is of paramount importance, and whenever possible the treatment should always be causal. Consequently, in otitic facial palsy—besides paracentesis of the tympanum which has given some results when the nerve has become involved in an acute otorrhœa—some successful results may be obtained by a mastoid operation which, if done early in the process, will act by the decompression obtained as well as by disinfection of the parts. Resection of the Fallopian canal may also be resorted to, and will give relief to the paralysis in certain cases, just as that obtained by neurolysis of a nerve included in a callus. When the palsy is due to syphilis an early and careful specific treatment will result in a complete recovery.

Now, although we are armed against facial palsies having a well-determined etiology, it is nevertheless a lamentable fact that a large majority of cases of paralysis of the seventh cranial nerve cannot be accounted for etiologically. It is true that a large number of these palsies *a frigore* is susceptible of spontaneous recovery, the exhibition of strychnin, arsenic and the iodides being all the treatment necessary. The electrical treatment, very useful for preserving the muscles during the evolution of the paralysis and warmly recommended as a therapeutic measure for the palsy itself, may, in some instances, bring about an amelioration, and even contribute to recovery. But this is always a delicate treatment that has often been incriminated as being responsible for the advent of certain unfortunate complications and the basis of which opinions vary greatly, because although Duchêne advised the faradic current, Remak only used the galvanic, and each school is sufficiently exclusivist for accusing the other of the damage done by electricity.

Consequently, although a certain number of cases of paralysis of the seventh cranial nerve may be cured by medical treatment alone, it is none the less true that very numerous also are the cases attributed to a more or less well-founded pathology which resist all kinds of purely medical treatment and many unfortunate patients have undergone months or years of treatment without the slightest benefit, when they were not made worse. However, the progress made by modern surgery has come to the rescue, and it is precisely for these facial

palsies, incurable by medical treatment, that nerve anastomosis was first advised by Ballance, and the idea farther carried out by J. L. Faure following the advice of Furet.

Surgery is not destined to deal with all the cases of facial paralysis and as Munch has very rightly said, "the surgeon can very happily complete the physician's work and an operation, far from being a substitute for medical therapeutics, commences where the latter left off." Therefore, medical therapeutics must not be carried out for too long a time. Although there are cases in which a surgical interference undertaken too early in the morbid process might lose any benefit accruing from nerve anastomosis, it is none the less true that a delayed operation may compromise the results in as much as muscular degeneration will have progressed too far. It is, however, true that this fear is not always justified, and as an example I would mention the case of a woman with facial palsy of twenty-one years' standing, who was operated on by Professor Girard, of Geneva, with a successful result.

In accord with most surgeons, I believe that six months of medical treatment without any improvement is amply sufficient to justify surgical interference. Briefly summarized, surgical treatment of facial palsy should be resorted to in every case where medical treatment has been without avail as in division of the nerve from trauma or operative work on the mastoid or ear. In the latter case no illusion can be cherished that spontaneous recovery will eventually occur, therefore immediate operation is indicated.

The various plastic procedures resorted to by Bouch, Lexer and others of the German school, although interesting, need not detain us, as the results are merely a gross mechanical correction of the condition and are in every way inferior to the functional and physiological restoration that only nerve anastomosis can obtain.

The experimental work carried out after the early clinical cases had been recorded have given unquestioned proof for the justification of nerve anastomosis as treatment for facial palsy, and I will briefly enumerate some.

Barrago-Ciarella undertook a series of experiments on dogs in order to ascertain if, in cases of facial paralysis resulting from division of the seventh cranial nerve at its exit from the stylomastoid foramen followed by immediate suture of the peripheral end of this nerve

to the central end of the accessory nerve, divided at its entrance at the internal aspect of the sternomastoid muscle, it would be possible to reestablish the lost functions of the muscles innervated by the facial.

These experiments were carried out on middle-aged dogs, the suture material being No. 0 silk on a fine Hagerdorn needle.

Dog weighing 6 kil. 700 grammes. By a double incision, one commencing above the tympanic bulb and carried down for eighteen centimetres, the second falling on the first, dissecting the superficial layers until the cervical portion of the sternomastoid muscle is reached. The facial nerve could then be divided at its exit from the stylomastoid foramen and the spinal at its entrance into the sternomastoid muscle. The two nerves were next approximated and an end-to-end anastomosis with two sutures, passing through the cut surfaces and brought out a half a centimetre below, was done. The cut muscles were then brought together and an attempt was made to cover them partially with those in the region of the stylomastoid foramen.

Dog weighing 7 kil. 500 grammes. The same technic was followed, only instead of attempting to cover the region of the stylomastoid foramen with muscle, the central end of the facial nerve was destroyed with the thermocautery.

Following these operations paralysis of the facial was very manifest. The dropping ear when stimulated did not react; the widely open eye could not close even when the conjunctiva was stimulated. The lip dropped. Electrical examination done at the end of the first week revealed a complete abolition of excitability to both the faradic and galvanic current applied to the facial nerve. About six months after the operation the functions had returned in the territory of the seventh cranial nerve; the two auricles of the ear contracted simultaneously and equally, both eyes could be closed perfectly and there was synergy of movement in both nostrils. Electric examination demonstrated beyond question that there was a complete return of the functions of the facial nerve.

Dog weighing 7 kil. 800 grammes. With a slightly different technic the peripheral end of the divided facial nerve (at its exit from the skull) was anastomosed with the central end of the pneumogastric which had been divided one centimetre below the superior laryngeal nerve. Immediately after the operation facial palsy was complete and electric examination revealed the reaction of degeneration thirty-two days after the operation.

At the end of six months some signs of return of the functions of the facial nerve were noted which became more accentuated by the eighth month. An electric examination, made four hundred and sixty-two days after the operation, showed that there was no reaction of degeneration and only a slight increase of the neuromuscular excitability on the operated side.

Post-mortem examination done shortly after showed that the nerve was composed by the central end of the vagus, then a small swelling at the spot where the sutures had been inserted, and then the facial with its ramifications.

A control dog in whom the facial had been resected offered no sign whatsoever of return of the functions and as conclusions to the data obtained, Barrago-Ciarella says that "in dogs suture of the divided central end of the spinal to the pneumogastric with the divided peripheral end of the facial is susceptible, if done immediately, of reëstablishing the functions of the muscles innervated by the latter nerve."

F. Villard also experimented with anastomosis of the facial with the hypoglossus and showed a dog at the Medical Society of Bordeaux that had been operated on successfully by anastomosing the peripheral end of the divided facial into a slit made in the hypoglossus.

Four months and a half after the operation movements of the tongue produced contraction of the face on the side operated on. Electric examination made three months after the operation showed a complete return of both galvanic and faradic excitability, and Villard came to the following conclusions to be found in Destelle's Thesis (Bordeaux, 1905):

1. "In dogs, anastomosis of the peripheral end of the divided facial with the hypoglossus, results in regeneration of the territory innervated by the seventh cranial nerve, if the operation is done at once after this nerve has been divided."

2. "Lateral anastomosis is sufficient to bring about regeneration of the divided nerve."

3. "The functional association of the movements of the tongue and face on the side operated on shows that the muscles of the face are then unquestionably innervated by the hypoglossus."

4. "Five months after anastomosis, although motility has returned for the past three months, a slight reëducation seems to have

taken place in the area of the facial innervating the auricle of the ear and forehead."

From these and other experiments we can conclude that surgical interference is justified in cases of facial palsy, while the histological proof has been furnished by Manasse. This observer anastomosed the facial nerve, divided at its exit from the skull, into a button-hole made in the spinal nerve. Of the seven dogs that survived the operation only five were reported on because at the time the paper was published the operation had been done only a short time before in one animal, while the second, the facial nerve had not been completely divided.

From the clinical viewpoint Manasse was less fortunate than the two preceding investigators. However, he was able to note the disappearance of the ptosis of the lip, as well as the deviation of the nose and mouth and a return of the normal tonus on the side operated on. He also noted very distinct contraction of the muscles on the operated side when, for example, one blew on the animal's head. Electric examination gives rise to marked contractions in the territory of the facial when this nerve was stimulated above the anastomosis with the spinal.

The dogs were killed and the anastomosed portion of the nerve was placed in Müller's fluid, modified according to Marchi, and afterwards stained by Weigert's method. Serial sections—about five hundred in all—showed that the nerve fibrillæ in the anastomosis passed directly from one nerve into the other. The plates illustrating the paper leave no doubt in this respect.

Although experimental work has furnished unquestionable proof of the rational value of nerve anastomosis in the treatment of facial palsy, and although clinically there is no longer any question as to the possibility of operative cure of hemiplegia of the face, nevertheless surgeons are divided in opinion as to the procedures to be employed. The great number of methods proposed and carried out prove that the method of choice has not been definitely settled and it must be admitted that the failures reported are largely due to imperfect technic, while some of the procedures have given rise to unfortunate complications.

I shall now endeavor to show that by certain changes in technic the greatest dangers of the operation may be avoided, thus making

the surgical treatment by nerve anastomosis a perfectly legitimate operation without any danger and susceptible of procuring a complete cure—a true *restitutio ad integrum*. But before discussing the value of the various operative procedures most commonly employed, I would refer to two that I am inclined to call *atypical*, because their indication seems to me so restricted.

The first is simple nerve union as employed by Sydenham, which consists in placing the divided nerve end to end in the aqueduct of Fallopius, the latter acting as a sheath, directing the nerve fibrillæ undergoing regeneration towards each other and thus bringing about repair of the nerve. This procedure was also employed by Marsh in two cases, and although ideal—since the nerve should unite without sutures—it is certainly very limited in its application. It is hardly necessary to remark that few cases of facial palsy could be treated by this procedure, because in order to be carried out the lesion of the nerve must be located in its intraosseous portion. Although it may be legitimate to place the divided ends of the nerve in apposition when the latter has been cut during a mastoid or middle-ear operation with the hope that regeneration may take place, it nevertheless seems rather fastidious to deliberately open the aqueduct of Fallopius for the purpose of placing therein the two ends of the divided nerve.

The second atypical operation is Laurent's cervico-facial anastomosis. Starting from the fact that the direction of the current in a nerve is indifferent, this observer supposed that in facial palsy an anastomosis between the seventh cranial nerve and mastoid or auricular branches of the superficial cervical plexus would be quite logical. He resorted to this operation in a child, anastomosing the branches of the facial at their exit from the parotid gland, the sternomastoid and auricular branches of the cervical plexus.

During the first few days following the interference the results were astonishing from the viewpoint of physiognomy, but afterwards the disfigurement returned, this being supposed to be due to giving way of the sutures. It is evident that in cases of division of the facial in the parotid gland or near to its entrance into the gland, this procedure might be essayed, because in the circumstance it would be impossible to attempt an anastomosis with the spinal or hypoglossus. This operation can only be regarded as useful in cases of anatomical necessity and is only theoretical at that, because this single case report

with the absence of any histo-physiologic proof cannot in any way support this technic.

The procedure purposed by Schaffer, of Edinburgh, need not detain us. This is anastomosis between the facial and glossopharyngeal nerves, and although theoretically it might be upheld, in practice this procedure would be a real complication.

I shall therefore only consider two procedures of anastomosis, the most commonly employed, namely, hypoglosso-facial and spino-facial, be it end-to-end or termino-lateral. And above all, let it be said that as far as cure of facial palsy is concerned, I am not a partisan of termino-lateral anastomosis, and in this group I include not only implantation, but also anastomosis of the facial with trapezial branch of the spinal nerve.

The idea of termino-lateral anastomosis was developed for avoiding paralysis in the territory of the nerve anastomosed with the facial. Now, theoretically, it should have been foreseen that this is not avoided, and clinically it has been proven. Termino-lateral anastomosis will not result in regeneration of paralyzed nerves unless there are quite a number of divided fibres in nerves whose trunk is not completely interrupted. But the division of these fibres unquestionably causes paralysis in the muscles to which they are destined.

Thus Körte, who was the first to perform simple inclusion of the facial nerve in the uninterrupted trunk of the hypoglossus, noted a paralysis of the corresponding half of the tongue. I have met with two identical instances in patients operated on by this procedure of implantation of the facial in the hypoglossus operated on by the late Professor Girard, both being followed by very marked atrophy of one-half of the tongue.

This, however, is not the principal drawback to termino-lateral anastomosis, which has been called an "antibiological procedure" by Hackenbruch. What is most serious in these cases is the continued association of every movement between the face and shoulder, or the face and tongue. It is evident, and it was quite logical to expect that every time the patient wished to raise the arm, he would direct his will by the intermediary of the spinal nerve and the nervous influx reaching the point of anastomosis would split, a part going to the spinal, the rest to the facial. The result is a disagreeable grimace synergetically accompanying every movement made by the shoulder.

It is true that some observers have advised methods of reëducation by means of a kind of rhythmical gymnastics, in the hope of correcting this nefarious association of movement. For example, Buchs recommends a series of exercises carried out by the patient while standing before a looking-glass under the control of the physician. These consist of raising the arm while the patient is ordered to contract the face, next to contract the face only in order to progressively obtain contraction of both halves of the face simultaneously.

It is not impossible that after a long reëducation, quite as tiresome for the patient as it is to the physician, these phenomena may decrease in intensity, but personally I place very little value on them, because in a case under my observation, in spite of all the patient still continued to make grimaces six years after an anastomosis of the facial with the trapezial branch of the spinal.

The same considerations apply to the hypoglossus, and although the movements of the tongue are less objectionable, they nevertheless exist. When the patient speaks these movements provoke a disordinated whirlwind of convulsions to such a degree that one wonders whether it would not have been better to have left the facial palsy as it was. Tillmann believes that reëducation may give results, but I believe that they can only be very limited in degree.

The end to be attained in the surgical treatment of facial palsy is not only tonicity of the muscles of the face and the possibility of their movement, as well as symmetry of the face during repose and voluntary movement, but—and this is precisely a *restitutio ad integrum*—a symmetry of the physiognomy during emotional movements. This result cannot, however, be realized unless the entire trunk of either the hypoglossus or the spinal—as the case may be—is completely sacrificed.

It is clear that for muscles having quite similar action, termino-lateral anastomosis may and should even be indicated, but between the face and the tongue, or face and shoulder, the difference is far too great. There remain, therefore, two procedures which to my mind are the only ones indicated for the treatment of facial hemiplegia, namely, total end-to-end anastomosis of the facial with either the spinal or the hypoglossus.

Of late it would seem that anastomosis with the hypoglossus is more generally favored, yet that with the spinal nerve has many ardent

supporters. From the viewpoint of technic the choice is about indifferent; some surgeons have found anastomosis with the spinal easier, others prefer the hypoglossus, which is said to be a larger nerve. From my personal researches on the cadaver and my operations the greatest difficulty encountered was to find the facial, but afterward I experienced no trouble in anastomosing it with either the spinal or hypoglossus.

Although the choice seems more favorable for hypoglossal-facial anastomosis this is especially because this seems to facilitate a more perfect synergy between the two sides of the face. Theoretically, there can be no doubt on the subject. The cerebral centre of the tongue in the cortico-motor zone of the cortex is in intimate contact with the centre of the muscles of the face in the lowest part of the frontal convolutions and ascending parietals. The centre of movement of the shoulder is located higher up in the middle third of these convolutions.

In the bulb, the facial nucleus situated on the prolongation of the caput of the anterior horns of the medulla is separated from the nucleus of the spinal by the entire portion of the nucleus from which the glossopharyngeal and pneumogastric take their origin. The nucleus of the hypoglossus, situated on the prolongation of the base of the anterior horns, is in communication with the nucleus of the facial by means of the longitudinal posterior band, and what is more, there is no other nerve originating between the nuclei of the seventh and twelfth cranial nerves.

This topography of the centres of the facial in their relation to the centres of the spinal and hypoglossus is shown in *Plate I*. From this it will be seen that on account of the rather intimate relations existing between the seventh and twelfth cranial nerves a more perfect functional result can be more readily obtained by an anastomosis of the facial with the hypoglossus. It is nevertheless true—and many examples exist—that with spino-facial anastomosis excellent results are obtained.

But whether the hypoglossus or the spinal be employed for the anastomosis, it cannot be too often repeated that the perfect result that may be expected can only be obtained by totally sacrificing the nerve from which a new nervous influx is to be borrowed. Now,

end-to-end anastomosis with the spinal will inevitably cause paralysis of the sternomastoid and trapezius muscles.

End-to-end anastomosis with the hypoglossus will fatally have as consequence paralysis of the tongue. *A propos* of this, some surgeons have questioned the propriety of attempting a cure of facial palsy by a procedure which, even in case of a successful result, would cause paralysis elsewhere.

It is clear that this new paralysis, created either of the shoulder or one side of the tongue, is less serious than paralysis of the face.

In respect to the spinal nerve we know that its external branch gives off ramifications to the sternomastoid and trapezius muscles, and it is likewise known that these muscles receive nerve branches from the cervical plexus.

Sternberg's researches on monkeys are interesting. This animal has a muscle which corresponds with certain fibres of the trapezius in man, and this observer concluded that the sternomastoid muscle was innervated only by some motor fibres of the spinal nerve, while the sensitive fibres were supplied to it by the cervical plexus. On the other hand, the spinal nerve and cervical plexus supply the trapezius muscle with its motor fibres.

Sternberg thus confirmed the hypothesis emitted by Remak, according to which only the acromial portion of the trapezius is innervated by the nerves of the cervical plexus, its clavicular portion being innervated only by the spinal. Having had the opportunity of observing a case of peripheral paralysis occurring after stretching of the accessory branch of Willis (eleventh cranial nerve) he was able to confirm his researches and described as consequence of peripheral paralysis of the external branch of the spinal, complete paralysis and atrophy of the sternomastoid muscle, paralysis and atrophy of the clavicular fasciculi of the trapezius (auxiliary respiratory muscles) with preservation of the acromial portion of the trapezius.

The same findings were made by Bolten in a subject with peripheral paralysis of the spinal nerve following a fall. This distribution of the nerve in question is no longer doubted since the numerous operations for facial palsy with division of the spinal for the purpose of anastomosis have been recorded and clinically confirmed it.

Now, paralysis of the clavicular fasciculus of the trapezius invariably results in a drop of the shoulder, although the atrophy of

these upper fasciculi of the trapezius do not greatly disturb certain movements of the head produced by the combined action of several muscles or the act of climbing, it is inevitable that the rising of the thorax and shoulder must be compromised since this act is accomplished by the clavicular fasciculi of the muscle.

In the same way, although paralysis of the sternomastoid still permits movements of rotation and bending forward of the head by substitution of other muscles of the neck, it compromises the possibility of keeping the thorax raised during prolonged expiration in singing, etc. Also in atrophy of the sternomastoid the æsthetic side must be considered which may be very important, especially in women.

Now, although division of the spinal nerve gives rise to all these disturbances, division of the hypoglossus produces paralysis of the corresponding side of the tongue which is still more serious. The result is very marked disturbance of speech, mastication, and above all, swallowing, which is often very pronounced, and the patient will always complain of the impossibility of swallowing liquids quickly.

These disturbances, first observed by Körte, following hypoglossofacial anastomosis, and which I have had the opportunity of observing in a number of cases of paralysis of the twelfth pair, may sometimes improve slightly, as Stewart has remarked. In these circumstances it may, perhaps, be admitted that a suprahyoid branch of the hypoglossus exists, has been described by Hyrn and later by Bach and Arnold, and it anastomoses in the middle line with a similar branch of the nerve on the opposite side, thus making a communication between them. As this anomaly exists in only 6 per cent. of subjects, it would not be rational to count on it for the regeneration of the peripheral end of the divided hypoglossus.

In three cases of hypoglossofacial anastomosis which I followed in Professor Girard's service, the paralysis of one-half of the tongue remain very marked, although more than five years had elapsed since the operation in all three.

From what has been said, we come to the conclusion that surgical treatment of facial palsy by an end-to-end anastomosis of the seventh cranial nerve with either the spinal or hypoglossus, will invariably result in marked disturbance of function either of the shoulder or tongue. This being the case, the question naturally arises as to whether or not these unfortunate operative sequels cannot be avoided.

It seems to me that this problem is most important to solve, because its solution would remove the dissatisfaction now reigning in respect to the surgical treatment of this process.

After experimental work on the cadaver, Grant, of Denver, developed the idea of completing end-to-end spino-facial anastomosis by an anastomosis of the peripheral end of the divided spinal nerve with the central end of the descending loop of the hypoglossus (*see Plate II*), and he carried out this procedure on January 26, 1910, in a case of facial palsy of four and a half months' standing. The paralysis resulted from a bullet wound in the ear. The result was excellent and the patient was not only cured of the facial paralysis, but there was no post-operative disturbance of the functions of the shoulder.

This excellent operation is to be highly recommended, both on account of its great technical simplicity and complete innocuousness, and since this has been attained in the case of the spinal nerve, is it not possible to accomplish hypoglosso-facial anastomosis without giving rise to functional disturbances of the tongue?

To attain this end result, Ballance made an anastomosis of the peripheral end of the hypoglossus with the central end of the lingual nerve after an end-to-end anastomosis between the hypoglossus and facial, but the result was *nil*.

Stoffel's experiments show that the nerve fibres in a nerve trunk are independent of each other, and taking this as a basis it occurred to me that an end-to-end anastomosis between the hypoglossus and facial might be done, dividing the former nerve very low down close to the border of the hypoglossus muscle and then complete the operation by an anastomosis of the peripheral end of the hypoglossus with the central end of its descending branch (*see Plate III*). This modification is very simple to carry out, but I suspect this in spite of Parhon, who maintains that there exists a certain independence between the cell groups which in the nucleus of the hypoglossus give rise to the fibres of its descending branch, this independence is not sufficient to assure perfect dissociation between the movements of the face and those of the tongue.

Perhaps this supposition is not justified, but should the clinical results prove this to be the case, I would suggest the following procedure. After anastomosis between the hypoglossus and facial, the

peripheral end of the former nerve is to be carried through the median line between the mylohyoid and hypoglossus muscles and anastomosed to the central end of the descending branch of the hypoglossus on the opposite side (*see Plate IV*). Although somewhat more complicated, this technic is perfectly feasible, as I have been able to prove by performing it some twelve times on the cadaver.

We consequently have two operative procedures which should result in perfect recovery of facial palsy, namely, by spino-facial anastomosis completed by Grant's operation, or by hypoglosso-facial anastomosis completed by either one of the two procedures described.

CONCLUSIONS

1. Surgical treatment of facial palsy by nerve anastomosis is logical and legitimate, as proven both by histology and experimental physiology.

2. Anastomosis of the facial with the hypoglossus is to be preferred—at least theoretically—although good results may ensue from anastomosis of the facial with the spinal nerve.

3. Hypoglosso-facial or spino-facial anastomosis should always be end-to-end, while complete sacrifice of the nerve, whose nervous influx is essential, must of necessity follow in order to avoid associated movements.

4. In order to prevent paralysis of the trapezius and sternomastoid muscles following spino-facial anastomosis, anastomosis of the peripheral end of the spinal with the central end of the descending branch of the hypoglossus must be done.

5. To avoid paralysis of one side of the tongue following hypoglosso-facial anastomosis, the peripheral end of the hypoglossus must be anastomosed with the central end of the descending branch of the hypoglossus on the same side, or else with the descending branch of this nerve on the opposite side.

TECHNIC OF HYSTERECTOMY

By MARK T. GOLDSTINE

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Chicago

IN presenting our method of performing hysterectomy we do not offer a radical change from any of the generally accepted methods, unless it be our rather unique way of suturing after the uterus has been removed. Our method, we believe, has made the work more simple and apparently quite safe as far as post-operative bleeding is concerned. It has yielded uniformly good results in our hands.

TECHNIC

Proper exposure of the field of operation is of utmost importance in pelvic surgery. We have availed ourselves of Guthrie's suggestion to begin the anæsthesia in the Trendelenburg position as we find it a considerable help and a great time saver. The time elapsing between the beginning of the anæsthesia until the abdomen is opened is usually sufficient to allow the loose intestines to gravitate toward the upper abdomen. Our incision is a relatively long one in the median line (Fig. 1) down to the symphysis, separating the rectus and pyramidalis muscles down to the bone. After incising the peritoneum the abdominal walls are lifted up, and if necessary, the intestines are pushed back toward the upper abdomen with a five yard roll of gauze. This is easily done owing to the fact that the patient, as already mentioned, has been in the Trendelenburg position for some time.

This minimizes the handling of the intestines to a great extent. A self-retaining new model Balfour retractor (Fig. 1) is inserted and gives us the full advantage of our incision with a resulting excellent exposure of the pelvic viscera.

It is not the object of this paper to deal with the indications for hysterectomy or the pathologic conditions of the uterus for which the operation is being performed. Therefore we will proceed with the details of the technic, taking it for granted that if the pelvis is well

exposed for operation so must the uterus and adnexa be in good view.

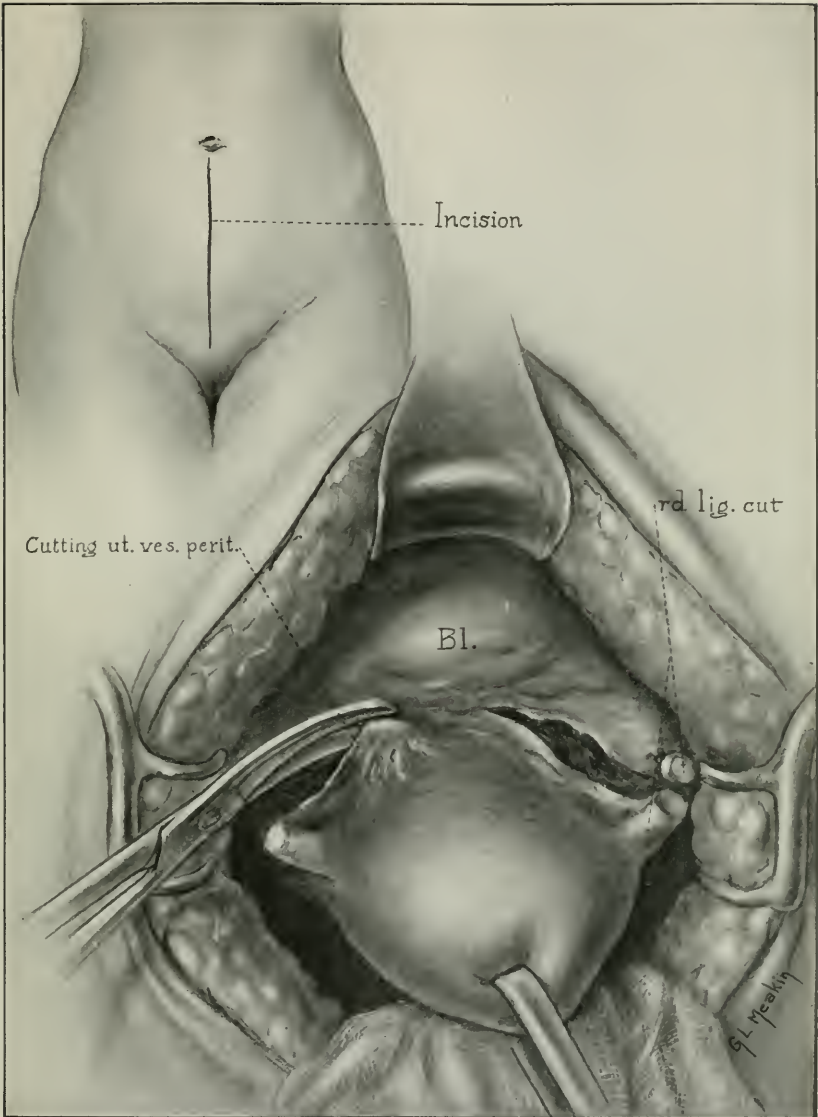
The fundus of the uterus is grasped firmly with a strong vulsellum forceps and drawn as close to the abdominal wall as possible (Fig. 1); the right round ligament is grasped with a Kocher forceps one inch from uterus, cut and ligated with catgut, after which forceps are removed. With a sharp pointed scissors the vesico uterine fold of peritoneum is incised from the point at which the round ligament was severed down to the reflection of the peritoneum on the anterior and lower portion of the fundus (Fig. 1). On the left side this procedure is repeated. The right and left peritoneal incisions are connected, the peritoneum is picked up with tissue forceps and separated downward by blunt dissection with scissors, keeping the points of the scissors toward the cervix.

Fig. 2.—The extent of this dissection downward depends on whether the operation is to be a panhysterectomy or an amputation of the uterus at some part of the cervix. This part of the technic assures us of ample peritoneum to cover all raw surfaces after the hysterectomy and gives a good exposure of the bladder (Fig. 2). The uterus is now drawn upward and to the left as far as possible and an eight-inch clamp (without teeth at the end) is applied obliquely downward and inward to the broad ligament, with the end of the clamp close up to the cervical tissue, including a small portion of the vaginal mucosa (Fig. 2). These clamps should be applied so as to leave behind the maximum amount of broad ligament consistent with the pathologic condition present. This step is repeated on the left side and the broad ligaments are severed after the application of both clamps (Fig. 2).

We are particular to cut the broad ligaments at least one-quarter to one-half inch from the clamp on the uterine side, thereby causing a marked eversion of the tissues in front of the clamp. This brings the large blood vessels into prominent relief (Fig. 2), where they can be ligated separately if one wishes supplementing our method of suturing which is to be described later. The two clamps will control the bleeding in 95 per cent. of hysterectomies whether panhysterectomy or supravaginal hysterectomy.

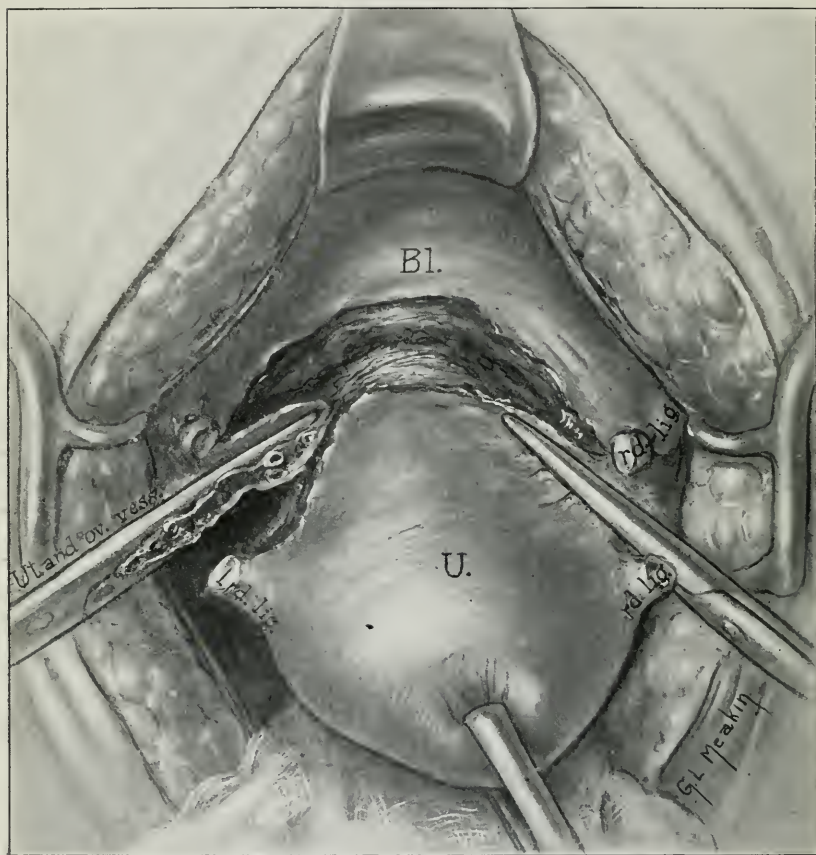
When the broad ligaments are exceptionally wide, or when one or both ovaries are left, an additional clamp may be required on one

FIG. 1.



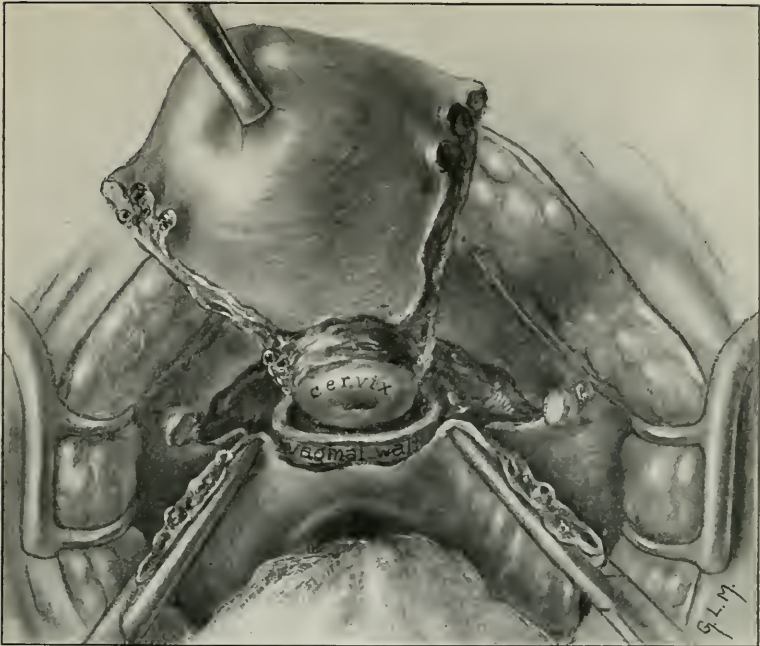
A, Showing initial abdominal incision. B, Round ligaments cut and ligated. Vesica-uterine peritoneum incised. In this and the following pictures the ovaries and tubes are not shown in order to give a clearer view of the field of operation.

FIG. 2.



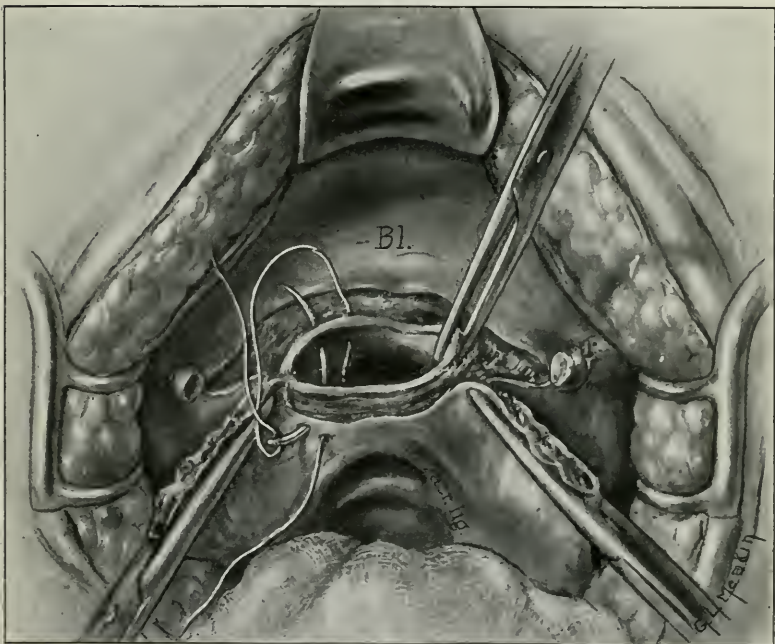
Clamps applied to broad ligaments eliminating round ligaments.

FIG. 3.



Both B. L. clamped and cut, showing eversion of tissues in front of clamp and prominence of blood vessels.

FIG. 4.



Uterus removed. Vaginal canal held up by forceps at right angle. Beginning of suture.

FIG. 5.

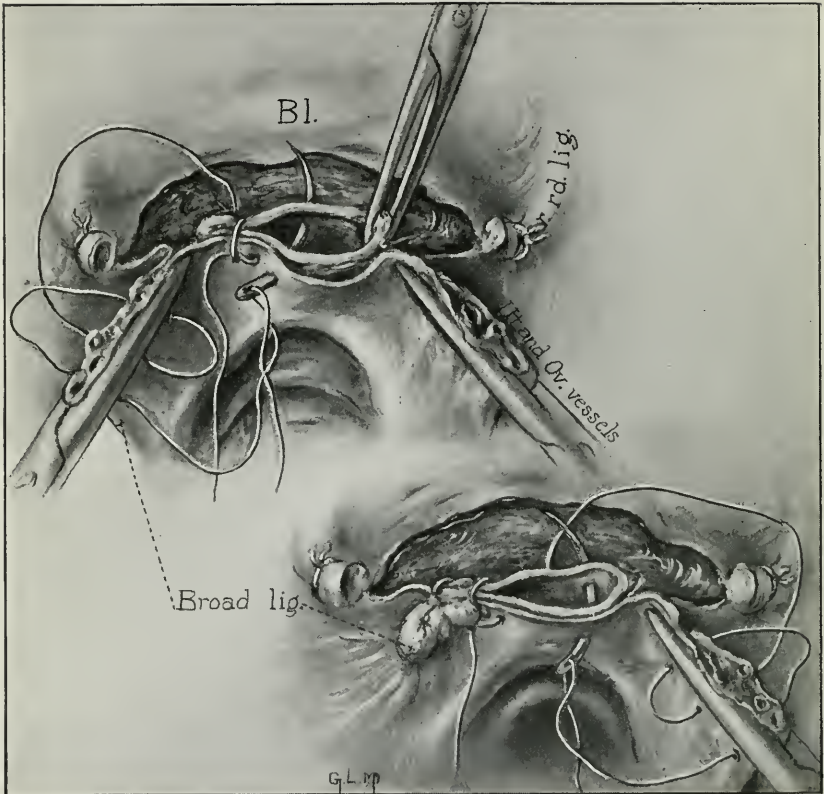


FIG. 6.

FIG. 5.—Suture applied to left side of vagina and B. L. suture drawn loosely for illustration.

FIG. 6.—Suture on left side drawn taut. Right side sutured and cross stitch in vagina taken.

or both sides. We attribute the efficiency of this method to the fact that we eliminate the round ligament. This being a firm, resistant, cord-like structure when included, prevents the proper compression of the broad ligament and allows the tissues to slip from the clamp after cutting; it also prevents the eversion already mentioned (Fig. 2). The uterus is removed *in toto* (Fig. 3) or at any desired level of the cervix (Fig. 7) by working from the posterior toward the anterior aspect, the vaginal wall is grasped at each angle (Figs. 5 and 6) to prevent its dropping too deeply into the cul-de-sac. (Fig. 4.) The posterior lip of the cervix is grasped with a tenaculum forceps for the same reason.

METHOD OF SUTURING

Chromicized catgut No 1 is used. We begin with a suture 30 inches long, double strand, mounted on a curved Schroeder needle. The suturing starts at the base of the left broad ligament either in the vaginal wall or cervix (Figs. 4-7), including both walls of the vagina or lips of the cervix. This stitch is immediately repeated, the needle entering the tissues to the right of the first stitch and emerging to the left, thus crossing the stitch to form the letter X (Fig. 5), which locks the suture, saves tying a knot and prevents slipping. The next stitch is through the broad ligament at the very tip of the clamp, then up two-thirds of the surface on the broad ligament, back again one-third of the distance. This takes in the middle portion of the broad ligament, then up to the top of the ligament, including the last third, and returning to the original starting place (Figs 5, 6 and 7). The clamp is now removed and the broad ligament drawn up snugly to the vagina or cervix (Fig. 6). In the illustration the suture is left open; this has been done to make it more easily understood; it is, of course, kept taut during the operation. Continuing with the same suture, one lock stitch across the vaginal wall or cervix carries the suture to the base of the right broad ligament. Here the same procedure is repeated (Figs. 6 and 7) as was done on the left side. This suture is drawn taut and one stitch brings it back to the starting place, where the first knot is tied (Fig. 8). This should immediately control all bleeding in an effective manner without any danger of subsequent hemorrhage and with perfect assurance that the ligature on the vessels will not slip.

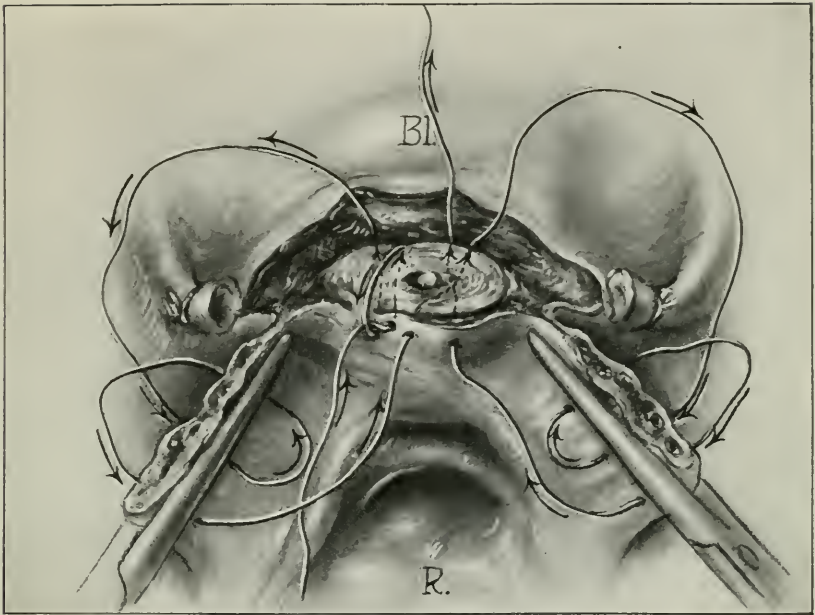
PERITONEAL COVERING OF THE DEFECT LEFT BY THE REMOVAL OF THE
UTERUS

Continuing with the original suture, the right and left round ligaments are picked up, the needle passing behind the catgut ligament; this prevents the suture from tearing through the end of the ligament. The ligaments are then drawn together over the vaginal canal or cervical stump (Figs. 9 and 10) and are anchored there by a lock stitch through those structures. We then pick up the edges of both broad ligaments and the edge of the bladder peritoneum on the left (Figs. 10-12); draw the suture up tightly and pick up the right side of the bladder peritoneum (Fig. 12); this completely carries all raw surfaces and the second knot is tied (Figs 12 and 13). The abdomen is closed in the usual manner.

SUMMARY

We have used this method since 1913 in a series of several hundred hysterectomies without a single case of post-operative bleeding and without any injury to the bladder or ureters that has come to our knowledge. We would emphasize particularly the utilization of the round ligaments to cover the vaginal or cervical canals, and the continuous mass suture. The former tends to give good support to the structures covered and the mass suture is very convenient, and as we have shown, when properly used is without any of the dangers which have been attributed to it.

FIG. 7.



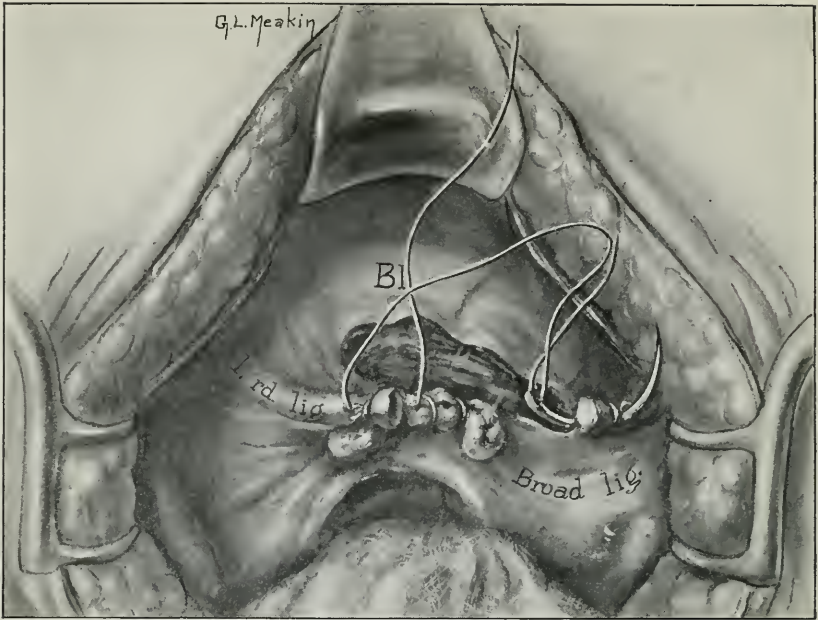
Suture in place as in Figs. 5 and 6 but the cervix is the base instead of vaginal walls. Arrows showing the direction suture takes.

FIG. 8.



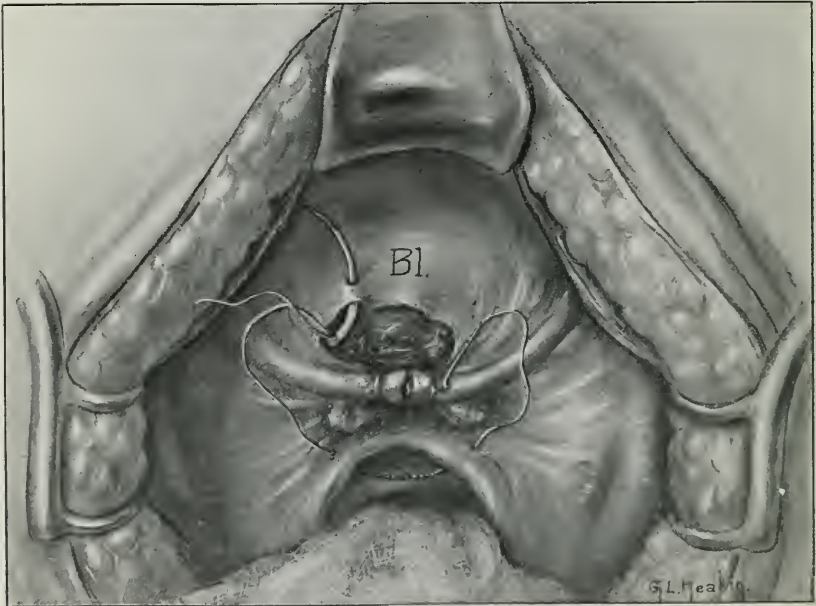
Both sides ligated and drawn taut. First knot in operation ready to tie. Completes hæmostasis and closes vaginal canal or cervix.

FIG. 9.



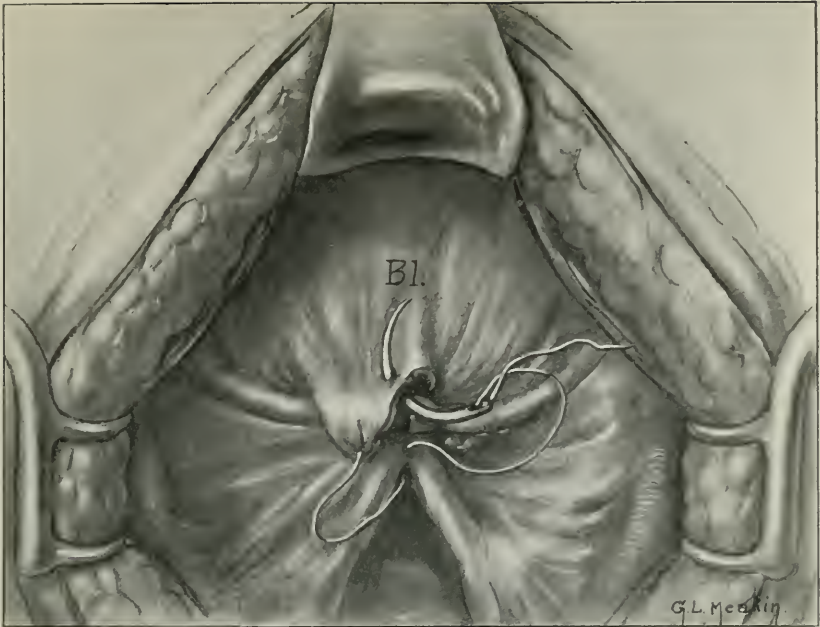
First knot tied, same suture being used to cover up defect. Left and right round ligaments being picked up.

FIG. 10.



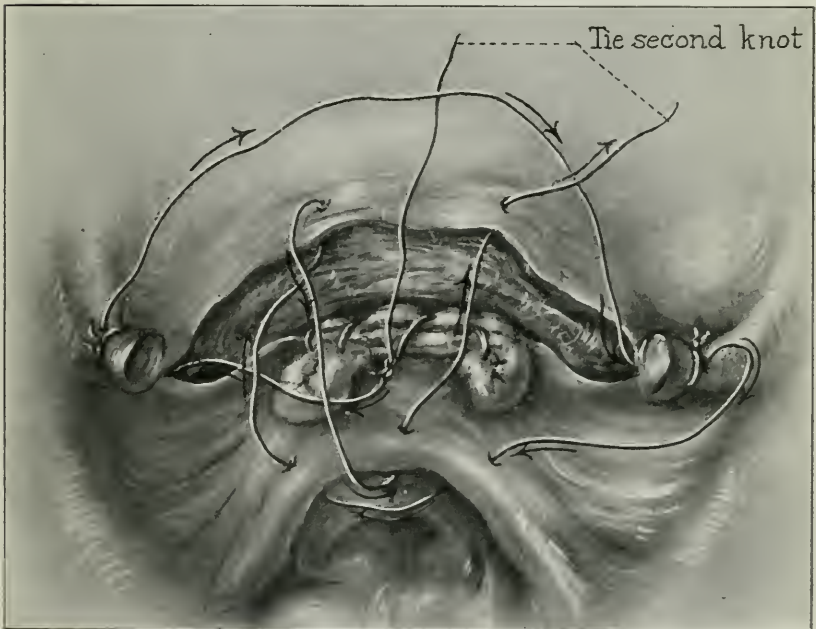
Round ligaments brought together and sutured over vaginal or cervical stump. Broad ligament sutured. First stitch in vesical peritoneum.

FIG. 11.



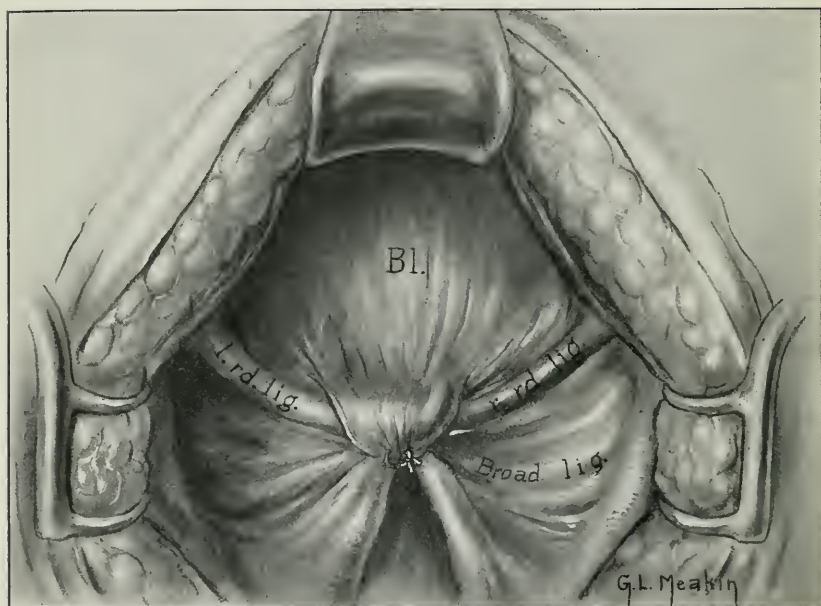
Broad ligaments reinforced and drawn to vaginal or cervical stump with vesical peritoneum partly drawn over. Last stitch taken in vesical peritoneum.

FIG. 12.



Open suture with arrows showing course of suture used in peritonization of defect just before second knot.

FIG. 13.



Second knot tied. Operation completed and all raw surfaces covered.

WOUNDS OF THE VESSELS OF THE FACE, NECK, AND LIMBS. THEIR SURGICAL TREATMENT, BASED UPON FOUR HUNDRED AND FORTY-THREE CASES

By ANDRÉ MAURER, M.D.

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(With illustrations, after the drawings of Drs. Rolland and Portes,
by A. Mittendorff.)

(Continued from Volume 1, Series 31)

WOUNDS OF THE ULNAR VESSELS

My series of these injuries comprises forty-three cases; in fourteen the lesion was in the upper third, or 30 per cent.; in twenty-one in the middle third, about 50 per cent., and eight times in the lower third or about 20 per cent. In most the entire vascular bundle was involved, but the artery bleeds; the veins rarely do. When there is a venous hemorrhage at the upper third of the forearm, it is usually from the *perforating vein of the elbow*. This vein, known by the name of deep median vein as well, is abnormal in its origins as well as its endings; but it always has the same physiologic value, which is to assure a free and easy communication between the deep and superficial circulation. Coming from the deep radial or ulnar veins, often from both, also receiving an anastomosis from the interosseous system, it always goes to the superficial system and ends in one of the superficial radial or median veins at the apex of the V represented by the median basilic and median cephalic, or into the former vein, but invariably reaching these vessels at their under surface. When the perforating vein is injured, it bleeds freely, because it drains the major part of the blood of the forearm, which normally circulates from the depths to the surface.

Although the ulnar artery and veins are generally injured together, I have, however, met with two cases of rupture of only one ulnar vein, in one of which the interosseous trunk was also injured.

In forty cases there was complete division of the cubital vessels and the remaining three presented a lateral wound of the artery alone, once combined with a wound of the brachial vein. In these three cases

the artery was injured in its upper third in two places, once in its middle third.

When the wound was in the middle or lower third of the ulnar vessels there was often inversion of the severed ends, so that there were few clots. Hæmatoma is more prone to occur in wounds of the upper third following the sheaths of the ulnar vessels or, by a retrograde course, the sheaths of the brachial vessels. The hæmatoma is walled in by the aponeurotic expansion of the biceps to which it imparts a dark blue color. The median nerve is stained red, is flattened out and being partially dissociated by blood can only be recognized from its situation. Occasionally, the hæmatoma extends still higher up, imbibing the internal aspect of the arm, giving it a blackish, ecchymotic aspect. Damage to the muscles may also be very considerable in some cases.

In this series the bones were injured in eighteen cases, or about 40 per cent. Both bones were fractured in six cases, three times in the upper third, twice in the middle third and once in the lower third. The ulna was alone fractured in eight cases, once incompletely, once in the upper third, six times in the middle third and once in the lower third. In two other cases the radius alone was fractured in its upper third.

The nerves were injured in nine cases, or a little over 20 per cent. The median was partially divided in two, completely in one, at the upper third. At the middle third the ulnar nerve was injured in five cases; partial division in one, total in three and in one there was complete division of both the ulnar and median nerves with fracture of the ulna. There was but one case of injury to the ulnar nerve in the lower third and there was also fracture of the ulna.

Therefore, when the nerves are injured at the same time as the ulnar vessels the median is the one involved when the wound is in the upper third of the forearm, while the ulnar is involved in the middle and lower third traumata. In the upper third the ulnar vessels have the median as a satellite nerve and only come in contact with the ulnar in the middle third of the forearm.

TREATMENT

The technic followed in all these cases was ligature above and below the lesion in the vessel. Exposure of the lesion is usually easy

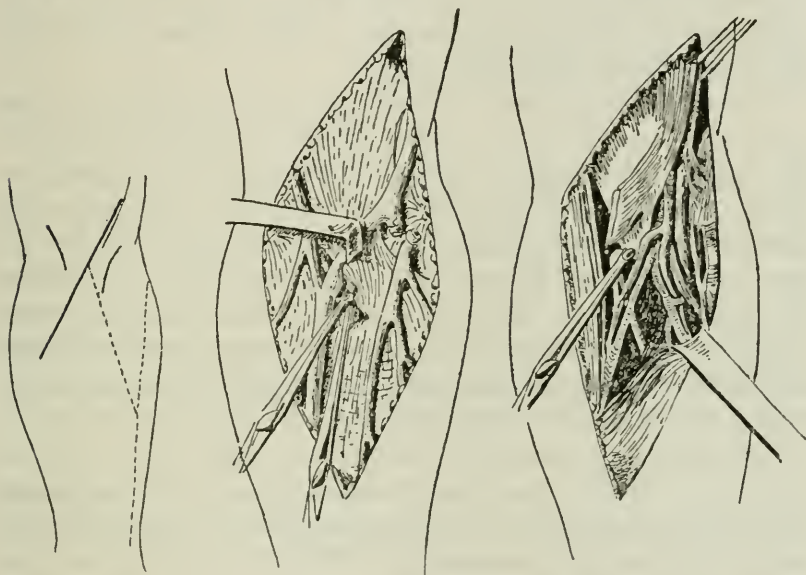
in all wounds of the radial and the ulnar in its two lower thirds. But the ulnar at the upper third of the forearm offers great difficulties sometimes, so that I would offer the following technical rules:

In a case of probable injury of the ulnar artery the brachial artery at the fold of the elbow should be exposed, according to Fara-beuf's technic. But the skin incision should be carried farther down to the extent of four fingers' breadth below the fold of the elbow,

FIG. 15.

FIG. 16.

FIG. 17.



Incisions permitting the approach to the humeral vessels at the elbow, radial vessels at the upper third and ulnar vessels throughout their course.

Division of the perforating vein at the fold of the elbow.

The radial and ulnar vessels at the upper third of the forearm and the origin of the interosseous vessels.

because not only the brachial artery must be inspected but its two branches as well (see Fig. 15).

The median basilic vein is freed and retracted outwards, and it is dissected up to the apex of the V that it forms with the median cephalic. It is then raised and at its under aspect the communicating vein of the elbow will be seen and is then divided between two hæmostats (see Fig. 16). Next the aponeuritic expansion of the biceps is incised and, the tendon of this muscle and the median nerve

being recognized, the brachial artery is dissected out with a grooved director and a temporary ligature applied (see Fig. 17).

The median nerve is then followed up; it gives off two branches to the pronator quadratus from its internal aspect and by following the large nerve trunk the epitrocheal fasciculus of the muscle is reached. Its upper border is detached and drawn down and inwardly (see Fig. 17). Thus a very excellent exposure of the brachio-radio-ulnar vascular junction can be obtained, but in some cases blood may still escape coming from an interosseous vessel or there may be a large hæmatoma accompanying the ulnar vessels. Therefore, to expose the vessels the clots must be turned out.

The pronator quadratus is often torn and the superficial flexor infiltrated, in which case a second incision is made following the ulnar vessels and reaches the middle of the fold of the elbow in the middle of the internal aspect of the forearm, thus coming back to Farabeuf's epitrochleo-pisiform line, and which itself can be utilized if the hæmatoma descends still farther down (see Plate XV). This applies to cases in which very important muscular lesions involve the epitrochlear muscles and the superficial flexor, in which the artery is injured in the segment extending from the ring of the superficial flexor to the mid-portion of the forearm.

It is not always necessary to resort to complete division. If, for example, the missile entered the antero-external aspect of the forearm and has become lodged under the superficial flexor not distant from the arch, it will usually be enough to divide it in the direction of the incision.

It may also happen that in a similar case myectomy has been sufficient, but the hæmatoma extends downwards along the ulnar vessels. Now, should the pronator quadratus, the common superficial flexor and the palmars be divided? I do not think so and it appears to me preferable to resort to the classic incision of the ulnar, expose the ulnar vessels at the middle third of the forearm and thus finish the surgical act.

ASSOCIATED VASCULAR LESIONS OF THE FOREARM

I have had twelve cases, comprising five in which both the radial and ulnar arteries were injured in the upper third, in one of which the median nerve was divided. In one case, at the middle third of the

forearm the median and ulnar nerves were divided and the ulna incompletely fractured. There were two cases at the lower third, one of which was complicated with fracture of radius and ulna.

In another case the radial vessels and interosseous artery were injured with fracture of the radius. In a case of injury at the middle third of the forearm the ulnar vein and the trunk of the interosseous vein were injured and both bones fractured. In another case the brachial vessels were torn near to their bifurcation to the extent of three centimetres and the radial and ulnar vessels to the extent of five centimetres. The case was a tearing away of the soft parts at the elbow and upper third of the anterior aspect of the forearm. Four days later amputation in the middle third of the arm was required for ischemic gangrene of the forearm.

There were three cases of injury to the brachial and ulnar vessels; in two the ulnar vessels were involved in their upper third, the missile becoming lodged in the brachial bundle, dividing all the vessels excepting one brachial vein in one, and completely in the second case. In another case the ulnar vessels were divided and the median nerve incompletely cut through and one brachial vein completely divided.

In one case the radial vessels were injured at the upper third of the forearm as well as the brachial artery at the elbow fold and the median nerve. There was also a fracture at the upper third of the radius.

It, therefore, results that in 16 per cent. of the cases a vascular lesion of the forearm may be accompanied by a lesion of another adjacent vessel. These lesions are usually well recovered from the viewpoint of the vitality of the limb, but this is not the case when severe damage to the parts requires extensive excision of the vessels in the territories of the brachial and its branches.

TREATMENT

The therapeutic consequence to be deduced from the frequency of associated lesions is that, when a vascular bundle is involved in the forearm, the other bundle and brachial vessels should be explored if there is any doubt as to the possibility of their involvement. The incisions described for exposing the ulnar vessels will give plenty of space for such an examination.

WOUNDS OF THE GLUTEAL VESSELS

Of these I have a series of twenty cases, as follows: Four cases of wounds near the sciatic notch and sixteen on the course of the gluteals. The gluteal veins usually form a plexus around their artery, thus explaining the simultaneous occurrence of wounds of artery and veins.

There is no region of the body so prone to hæmatoma as the gluteal; it cleaves the muscular planes, dissociates their fibres, infiltrates the sciatic and may extend down alongside this nerve to the middle of the thigh. The gluteal region is distended, hard, tense and painful. It is one of the regions where gas gangrene finds a favorable soil. It also often happens that the wounds in the buttocks are multiple, as many as five or six apertures being noted, with the missiles deeply seated and more or less remote from each other. Cleansing and trimming off the muscles is more important here than anywhere else. Radioscopic location of the missiles is less distinct and precise than elsewhere in the body. The course of the missile must be followed step by step in order to be sure to reach it and the bits of clothing that accompany it.

In four out of my twenty cases (20 per cent.) there was, with the wounded vessels, a fracture of the iliac wing, the missile being lodged in the midst of the iliac muscle or under the peritoneum or even in the pelvic cavity. This is still another reason for following very exactly the course of the traumatic agent, because fractures of the iliac wing are not usually detected during radioscopy. The tracts must also be thoroughly drained in order to avoid serious infection later on.

The ischium is also the seat of fractures in 10 per cent. of the cases, which brings the total of fractures of the iliac bone up to 30 per cent. in cases of lesion of the gluteal vessels. I also met with a case of incomplete fracture of the sacrum, hence a total of seven fractures out of twenty cases of wounds of the gluteal vessels, making the frequency of bone lesions 35 per cent. in these cases.

TREATMENT

In the buttocks the muscular and osseous drainage is so important that one must first ascertain if they can be properly treated, and not

leave in their midst a foreign body, missile and, above all, bits of clothing. Therefore, long incisions parallel with the fibres of the gluteus major should be made. The necessary myectomy and other cleansing processes are then done by following inch by inch the tract of the missile. This is a good technic for dealing with the muscular lesions, and at the same time there is usually no very great difficulty in controlling the bleeding.

In a certain number of cases, when the gluteal artery is wounded near the great sciatic notch it may be well to divide the aponeurosis in front of the gluteus major and then detach and retract the muscle inwardly in order to expose the vessel at its exit from the sciatic notch, as advised by Fiolle and Delmas.

This is an ingenious procedure, but I think before resorting to it the muscular lesions should be dealt with, as well as the tract of the missile, which will be easier to carry out before the gluteus major has been freed at its anterosuperior border.

Although by this procedure the gluteal vessels are nicely exposed, the ischiatic vessel and internal pudic are less easily reached. Also, the incision advised is very long, and should one be obliged to plug the wound without sutures, this incision necessitates a considerable detachment of the gluteus major. This muscle, which belongs to the deltoid system of the gluteus, offers aponeurotic attachments above and anteriorly, which are themselves quite as important as its osseous attachments. It is for this reason that I have devised a procedure by which the superior ischiatic vessels and internal pudics can be exposed by a much shorter single incision.

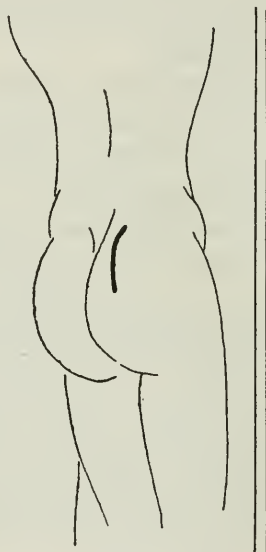
At their emergence, these vessels are covered by the gluteus major. The gluteal vascular bundle comes out above the upper border of the pyramidal, those of the ischiatics and internal pudics under the lower border of this muscle. The two points of emergence, situated on a vertical line, are three centimetres distant from each other. This distance represents the breadth of the pyramidal muscle at this point (see Fig. 20).

The incision I advise commences from two to three fingers' breadth from the intergluteal depression and carried parallel to it and then is given a slightly curved direction in order to reach the posterior extremity of the iliac crest. The incision measures twelve centimetres

(see Fig. 18) and is carried down directly to the osteofibrous plane, transversely dividing the upper fibres of the gluteus major. The postero-external tubercles can be felt while the upper border and a portion of the posterior aspect of the great sacrosciatic ligament can be seen; it is the first landmark (see Fig. 19).

The second landmark is the pyramidal muscle. By strongly retracting the external border of the incision a cleavage plane can easily be found. A muscle directed transversely appears (see Fig. 20) and

FIG. 18.

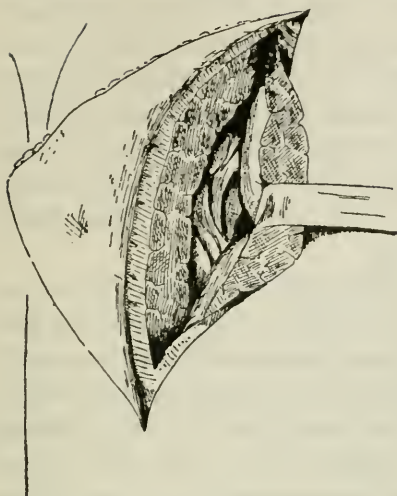


Incision for exposing the gluteal, ischiatic and internal pudic at their exit from the great sacro-sciatic notch.

its upper border searched for at four fingers' breadth from the mid-line between this muscle and the apex of the great sciatic notch the gluteal artery will be found, accompanied by two satellite veins, which present anastomoses, while below them and externally the superior gluteal nerve will be seen running upwards and outwards (see Fig. 21).

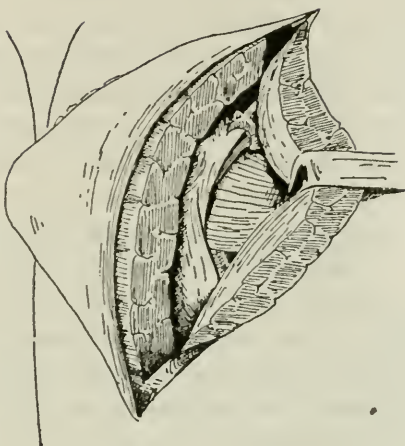
Aside from the difficulties presented by the hæmatoma, there are others which are due to the thick fat infiltrated with blood and occasionally also from the upper and recurrent fibres of the great sacrosciatic ligament which extend up to the apex of the sciatic notch.

FIG. 19.



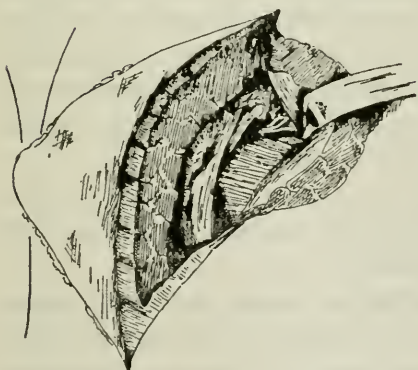
Division of the gluteus major. The incision is carried down to the osteo-fibrous plane: postero-external tubercles of the sacrum and origin of the great sacrospinous ligament.

FIG. 20.



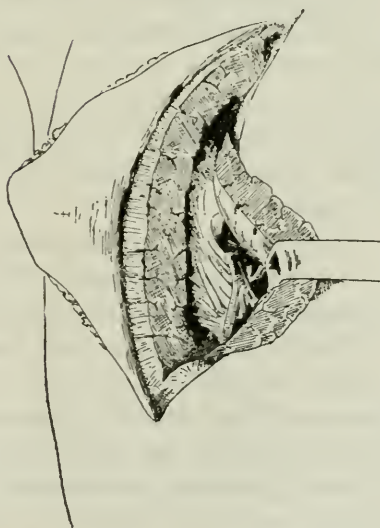
Vessels of the gluteal region. The external lip of the gluteus major is retracted outwards, exposing the pyramidal muscle, from whose upper and lower borders various vascular bundles emerge.

FIG. 21.



Exposure of the upper superior gluteal vessels and nerve.

FIG. 22.



Exposure of the ischiatic vessels, nerve and internal pudic vessels.

It will then be necessary to divide them transversely in order to freely work to the inner side of the vessels. But more particularly are the difficulties encountered resulting from the fact that the arch of the gluteal vessels is adherent quite close to the edge of the great sciatic notch, so that these vascular attachments are difficult to dissect off. The veins are plexiform and friable; therefore, careful contact with the bone must be maintained, and the vascular bundle must be freed by blunt dissection on its outer and inner borders before attempting to pass a ligature under it.

Exposure of the ischiatic and internal pudics is easy. Under the lower border of the pyramidal, four fingers' breadth from the midline, in an angle with a sinus opened downwardly and outwardly formed by the lower border of the muscle and the great sacrosciatic ligament, the ischiatic vessels will be found (see Fig. 22). Having verified them, the operation is continued more to the outer side and a series of organs will be successively encountered, having an oblique direction downwards and inwardly. These are the internal pudic nerve and internal pudic vessels, the artery flanked by its two veins going towards the lesser sciatic notch, while superficially in relation to them and crossing them is a large branch of the ischiatic artery running downwards and outwards.

After dealing with the vascular lesions the operative wound may, in some cases, be closed by a few catgut sutures comprising the fibres of the gluteus major and deep in the wound, some of the aponeurotic fibres covering the external border of the sacrum or belonging to the great sacrosciatic ligament, thus assuring a new and solid muscular fixation.

This procedure can be resorted to in about 20 per cent. of these cases when a missile is supposed to have involved the region of the emergence of the vessels of the buttock.

But it may happen that the gluteal vessels have been injured within the pelvis, the vascular lesion being usually accompanied by fracture of the brim of the great sciatic notch. In these circumstances the upper part of the notch is cleaned of the structures adhering to it, then subperiosteal sequestectomy of the fracture is done and the edges evened off. A ligature can also be placed on the trunk of the gluteal artery.

There are cases, however, in which this technic would be difficult,

because of the severe bleeding or because the vessels cannot be sufficiently detached for the purpose of passing a ligature under them, so that in these circumstances ligature of the hypogastric artery must be done. This is also indicated in secondary hemorrhage from the gluteal artery when injured near the great sciatic notch and should be undertaken by a median transperitoneal incision, lifting up the cæcum on the right and occasionally detaching the sigmoid flexure on the left.

WOUNDS OF THE SUPERFICIAL FEMORAL VESSELS

My series of these injuries comprise thirty-nine cases, as follows: Four in the upper third, or about 10 per cent.; nineteen in the middle third, or about 50 per cent., and sixteen in the lower third, or about 40 per cent. An important fact is that in 53 per cent. of these cases only *one* vessel in the vascular bundle was injured. Thus, there were eighteen cases of injury to both artery and vein, ten cases of injury to the artery only and eleven cases of the vein only.

The type of lesions were: One case of contusion of the artery with a severe injury of the hip; in two there were dissimilar lesions of the femoral artery and vein. One was division of the artery and a lateral wound in the vein, the other presented just the inverse condition.

Of the remaining thirty-six cases, twenty-nine presented total division of either the artery or vein, and in seven there was a lateral wound of one vessel.

The seven cases of lateral wounds were: One case of lateral wound of both artery and vein, four cases of lateral wound of the artery and two cases of lateral wound in the vein.

The hæmatoma present frequently extended far from the site of the lesion following the vascular sheaths, yet another argument in favor of an ample exposure of the vessels. For example, it is uncommon in a vascular lesion at the lower third of the thigh for the blood to remain localized there and not to extend into the popliteal space. More than for any other vascular bundle is it necessary, when the course of the missile appears to involve the area of the vessels, to completely expose the superficial femoral vessels and still more to complete this by inspection of the deep vessels when the wound is in the upper two-thirds of the thigh.

It was by applying this rule that my friend Bréssard, in a case
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of shell wound in the middle third of the thigh discovered that the superficial femoral vein was completely divided. In another case he found that the superficial and deep femoral vessels had been ruptured.

Such extensive damage to the vessels caused ischemic gangrene of the limb and amputation in the middle third of the thigh was done three days after the first interference.

It was by systematic exploration of the vascular bundle that Proust discovered a dry wound of the femoral vein at the middle third of the thigh; the vessel was divided and a clot occluded the lumen. A double ligature was applied, and the patient made an uneventful recovery.

To this case I would add two dry lateral wounds of the femoral artery. The first was treated by ligature above and below the lesion, but was followed by ischemic gangrene and a sausage amputation was done four days later. The second was a soldier who had remained on the battlefield for four days before he was brought in. There was gangrene of the foot. The femoral artery presented a dry lateral wound in the middle third of the thigh. A double ligature was applied, after which the leg was amputated at the lower third.

Damage to the soft structures is sometimes considerable and necessitates amputation. I saw one case in another ambulance of rupture of the femoral vessels at the bottom of a vast wound involving the muscles of the internal aspect of the thigh and those of the posterior aspect with division of the sciatic nerve. Patient was severely shocked but rallied after the usual treatment. Sausage amputation was done, but death occurred in a few hours.

The femur was injured in about 25 per cent. of my cases; there were three joint fractures, one at the hip, two at the knee, and seven fractures of the diaphysis.

In one case the head of the femur was crushed, there was a contusion of the femoral artery and gas gangrene had set in. Excision of the hip, extensive myectomy and a double ligature of the femoral were done. Death in forty-eight hours.

In two other cases there was fracture of the knee with rupture of the femoral vein. In both amputation at the lower third of the thigh had to be done.

There were seven cases of fracture of the diaphysis, one of these

being incomplete. Three cases occurred at the middle third, and one of these was accompanied by an extensive muscular laceration, requiring primary amputation. Three cases of fracture at the lower third, two being comminuted, for which primary amputation was done.

The nerves involved are the internal saphenous and its accessory, the vastus internus nerve, but they are usually overshadowed by the vascular lesions and are not discovered. It is only when the sciatic is involved that trouble need be feared, both on account of late functional disturbances as well as the severe immediate shock to which such lesions give rise. Fortunately, wounds of this nerve are rare and I have not met with a case.

WOUNDS OF THE DEEP FEMORAL VESSELS

I have had nine cases: Two cases of lesions of both artery and vein, one being accompanied by lesions of the superficial femorals. Six cases in which the artery alone was injured and one of both the deep and superficial femoral veins. In every case the vessel was completely divided, and in most of them there was a large hæmatoma in the vessel sheath. The search for the lesion and ligature of the vessel is difficult unless an exact technic is followed, and for this reason I shall enter into some detail. In these wounds of the deep femorals twice there was fracture of the femur and once the ischium.

These lesions are serious, because death may occur on the battlefield from severe hemorrhage or during transportation to the ambulance, also during or soon after operation from anæmia or shock. On the other hand, the importance of the vascular lesion, the association of several other arterial or venous lesions are sometimes such that, in spite of temporary hæmostasis, bleeding continues.

After operation, if the case has been brought late to the ambulance, gas gangrene has found all the conditions favorable for its development, particularly in wounds from exploding shell with irregular wounds, large lacerated muscular masses; large vessels divided, hæmatoma compressing the collaterals hinders nutrition of the limb and also helps in the development of anaërobic bacteria. The lesions may be situated so high up that amputation is impossible.

The condition of the limb in these cases may necessitate amputation; first, on account of the tourniquet when left on for a long time; the patient is brought in with a cold, violet limb with con-

siderable swelling. On account of important bone lesions, division of the sciatic nerve or severe damage to the muscles primary amputation may be necessary.

Secondary amputation may be required when, after ligature, ischemic gangrene arises, which is more prone to occur when a hæmatoma has compressed the collaterals for some time, or from poor circulation an infection develops in the limb.

I have had thirty-nine cases of ischemic gangrene; in one there was great damage to the superficial and deep femoral vessels. In two others, already referred to, the trunk of the femoral was ligated, and in the second the superficial femoral at the middle third without ligature of its vein. Both these cases are in favor of Makin's theory, which maintains that ligature of the large arteries is more dangerous to the life of the limb when the satellite vein is not also ligated.

These vascular wounds frequently result in a certain degree of functional impotency, and in an apparently cured patient, pain and intermittent claudication are met with. The gravity of wounds of the femoral vessels is shown by the following data: Out of forty-eight cases there were seven deaths, or 14.5 per cent. Of the surviving forty-two cases primary amputation at the thigh had to be done in 14.5 per cent. Secondary amputation, one at the thigh, the other at the leg; therefore, 4 per cent. of the total number of cases, making a total of nine amputations, or 18.5 per cent. Otherwise put, out of one hundred cases of wounds of the femoral vessels, thirty-three deaths occurred, or amputation was done, and these figures only concern patients treated at an auto-chir or field hospital. They do not include those patients who died before reaching these formations nor those who died or were amputated in the hospitals at the rear.

TREATMENT

The femoral is a large artery the ligature of which is dangerous. Suture would be the ideal treatment, but at the front conditions necessary for its proper technic are rarely fulfilled. It has seemed to me that in the majority of these injuries simultaneous ligature of the artery and vein should be done. Wounds of the femoral vein are always to be treated by ligature.

The technic to be followed in wounds of the femoral vessels is different when the lesion is in the two upper thirds of the superficial

femoral from that of a lesion of the lower third, where the femoral ends and the popliteal begins. Therefore, two regions are to be distinguished, the first extending from the crural canal to the entrance of Hunter's canal, the second starting at the latter down to the entrance of the femoral artery into the ring of the third adductor.

In the first region a missile may involve the superficial femoral vessels and the deep ones as well, so that at operation these should be inspected. It may very well happen that the superficial bundles and the deep bundle are simultaneously injured, just as it may happen that only one bundle is involved, so that a procedure should be adopted which will expose all the vessels of the region for inspection.

In the second region (Hunter's canal, ring of the third adductor) a wound of the femoral vessels often gives rise to a hæmatoma descending towards the popliteal space, just as a wound in the latter region may give rise to a collection of blood extending more or less higher up on the internal aspect of the thigh following the vascular sheath. Consequently, the femoro-popliteal course of the vessels should be exposed and I shall now describe the procedure to follow in each region.

I. TREATMENT OF WOUNDS OF THE SUPERFICIAL FEMORAL VESSELS FROM THE CRURAL CANAL TO HUNTER'S CANAL—EXPOSURE AND TREATMENT OF THE DEEP FEMORAL VESSELS

I shall first make a few observations on the anatomy of the deep femoral vessels based on thirty dissections carried out for the purpose of a more detailed study of these vessels.

The femoral artery arises four centimetres below the Poupart's ligament from the postero-external aspect of the main trunk and its average calibre is equal to about three-fourths of the superficial femoral; it is usually larger than the brachial. Taken altogether, the course of the deep femoral is vertical.

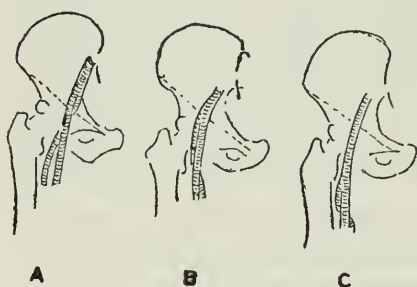
Its relations to the femur are as follows: In a frontal plane the artery corresponds with the lesser trochanter (see Fig. 23, C), then it approaches the *linea aspera*, which it reaches at its mid-portion; or the artery descends vertically, the femur is oblique with an inward direction, so that the artery finally crosses the bone, becoming posterior to it. In an antero-posterior plane, the artery crosses the internal surface of the femur, going from the internal border of the bone to the *linea aspera*.

In its relation to the superficial femoral, the deep femoral is behind it, but *above* it is nearer to the external aspect of the superficial femoral and appears as if anchored outwardly to the vastus intermedius and vastus internus by the artery of the quadriceps femoris (see Fig. 25). Below, it is nearer to the internal aspect of the superficial femoral and appears as if drawn inwardly by the branches it gives off to the adductor muscles.

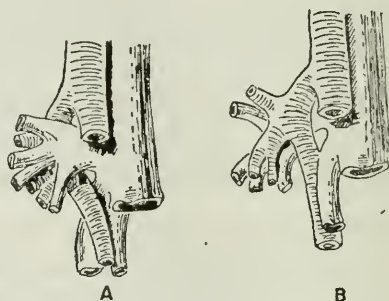
The relations of the deep femoral may be conveniently considered in two segments; the first is above the upper border of the adductor magnus muscle, the second is below it. Above the upper border of the adductor magnus the artery will be found at the bottom of a dihedral

FIG. 23.

FIG. 24.



Origin of the deep femoral artery. A, Very high origin near the innominate line (L. H. Farabeuf). B, Origin at the level of the crural ring. C, Normal origin near the lesser trochanter.



A, Origin of the deep femoral artery. This is usually hidden behind the large horizontal venous trunk of the quadriceps femoris. B, Abnormally large, horizontal, venous trunk of the quadriceps passing behind the origin of the deep femoral artery.

angle with a limited posterior ridge. Outwardly, by the musculocutaneous vertical wall formed by the psoas at its termination on the lesser trochanter and lower down by the vastus internus. Inwardly, by an oblique muscular plane running down and outwardly and formed by the lower external fourth of the pectineus, a thin tendinous muscle; by the upper border of the adductor brevis crossed by the deep femoral vein which comes close to its artery.

In front, the artery is in relation to the superficial femoral artery at the external half of its posterior surface. At its antero-external portion the internal saphenous nerve descends with its accessory on its inner side (see Fig. 25). The large venous trunk of the quadriceps femoris, which is often double, having a horizontal direction near its anastomosis, crossed by the nerve of the vastus internus almost

vertically, slightly oblique downwards and outwardly (see Fig. 24, A, and Figs. 25 and 26).

Below the lower border of the venous trunk of the quadriceps femoris, the deep femoral again is in proximity to the superficial femoral artery and then afterwards with the trunk of the femoral vein. This vein which is continued by the superficial femoral vein receives the deep femoral vein on its postero-internal aspect. The point of the superficial and deep venous confluence is situated five centimetres below that of the homonymous arterial confluence. Otherwise put, in the first five centimetres of its course the deep femoral artery is in proximity to the main trunk of the femoral vein. These relations are, however, not intimate excepting in the two to three lower centimetres; higher up, the trunk of the femoral vein is much more to the inner side and separated by the superficial femoral artery from the deep femoral artery (see Figs. 25 and 26). The latter only meets the vein quite low down, this vessel being *in front* of it and then tends to become internal to it.

The deep femoral vein covering the antero-internal aspect of the deep femoral artery separates it from the superficial femoral vein, which is more to the front, and from the superficial femoral artery, which is still more to the front. I would recall that in this region the trunk of the femoral vein and the deep femoral vein received the veins coming from the adductor muscles on their internal aspect (see Fig. 25).

In the second section, behind the adductor magnus, the deep femoral artery is in contact with the adductor magnus in front of its entire external aponeurotic portion (see Fig. 26); behind, with adductor brevis, then with the adductor magnus. To the outer side the artery is in relation with the femur, more especially with the linea aspera, to which the vessel is anchored by its perforating branches; it is proximate to the insertions of the vastus internus, from which it is separated by those of the adductor magnus which are in direct contact with it.

On the inner side it is the deep femoral vein which, antero-internal above, becomes internal and posterior to it in this region.

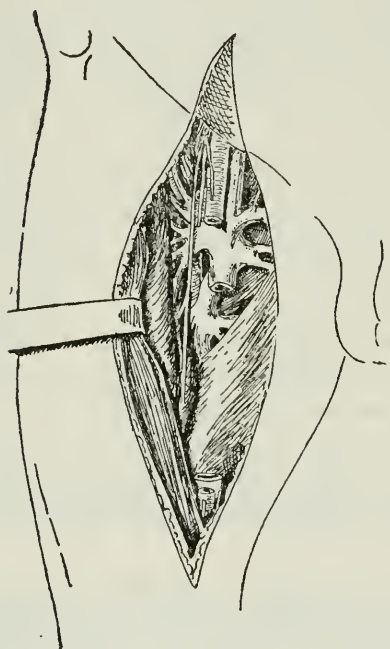
The *collaterals* may be divided into external and internal. The external collaterals in the *first segment* are the artery of the quadriceps and external or anterior circumflex, which frequently arise in

a common trunk. The internal collaterals are the internal or posterior circumflex and the branches going to the adductors.

In the *second segment* the external collaterals are the two perforating arteries, while the internal go to the adductor muscles.

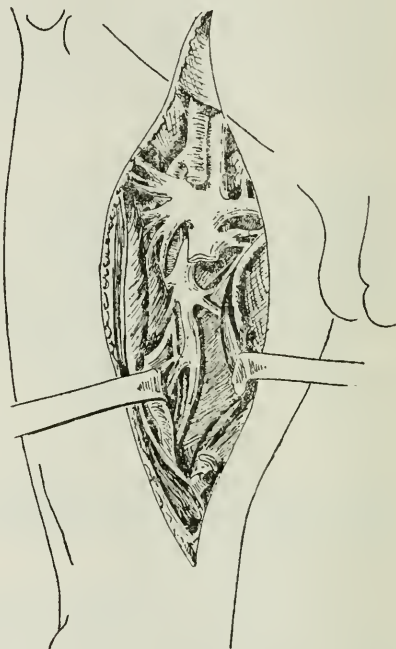
The deep femoral artery ends in a third perforating artery, usually at the junction of the middle and lower third of the femur.

FIG. 25.



Superficial femoral vessels divided. The internal saphenous nerve and its accessory descend in front of them. The deep femoral vessels are seen above the upper border of the middle adductor muscle. The deep femoral artery is hidden at its origin by the venous layer of the quadriceps, in front of which the nerve of the vastus internus descends. Farther down the deep femoral artery becomes the satellite of its homonymous vein which is in front of and internal to it.

FIG. 26.



Deep femoral vessels, showing their arrangement behind the middle adductor muscle which has been divided.

There are a certain number of anomalies with which the surgeon should be familiar. The origin of the deep femoral artery arises at the annulus femoralis (see Fig. 23, B), or very high up at the middle of the innominate line (see Fig. 23, A), or low down, ten centimetres

below the femoral ring, in which case the artery of the quadriceps and the circumflexes are given off by the main femoral trunk.

The calibre of the deep femoral may be as large or even larger than the superficial. In cases of high bifurcation of the common femoral trunk, the deep femoral may be almost completely external or internal to the superficial femoral, in which case it is *in the same plane* as the latter vessel.

The anomalies in relationship mostly concern the veins. The large vein of the quadriceps may be posterior to the artery (see Fig. 24, B). The deep femoral vein may be behind the artery throughout its course, in which case the deep femoral artery is between two venous beds, an interesting arrangement to know of when the surgeon is to ligate the deep femoral vessels. Finally, in some cases important hemorrhage may arise in the posterior space of the thigh with or without fracture of the femur.

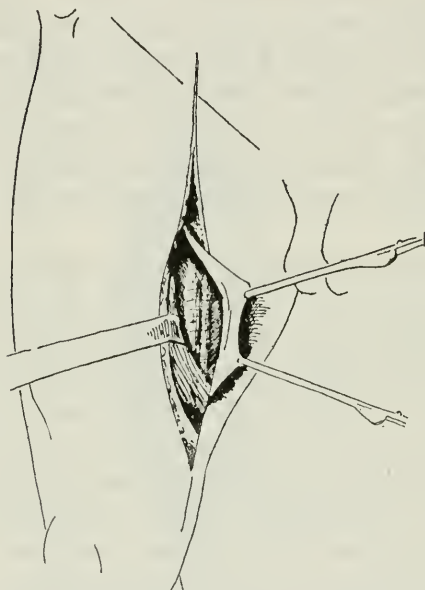
The explanation can be found in an abnormal venous circulation or in anomalies, such as I have met with in my dissections. It was a case in which a popliteal vein bifurcated to again become united in a single vein at the upper part of the popliteal space. From this point the vein ran up in contact with the sciatic nerve into the posterior space of the thigh, which it left two fingers' breadth from the gluteal fold to pass into the anterior region, thus constituting a deep femoral vein with an abnormal course. It anastomosed with a superficial femoral vein which, small and plexiform in the popliteal space anastomosed at its origin with the popliteal vein. This superficial femoral vein accompanied its artery and became single and well developed at the upper part of Hunter's canal.

TECHNIC

To deal with a wound of the superficial and deep femoral vessels seated between the femoral ring and the entrance to Hunter's canal, Farabeuf's incision should be used, starting at the middle of the ring and ending behind the internal condyle. First, the incision is carried down to the extent of ten centimetres, as for ligature of the femoral, to the apex of Scarpa's triangle. The internal border of the sartorius being exposed, the muscle is retracted outwards (see Fig. 27) when the femoral artery in its sheath will be seen. The incision is then enlarged upwards and, under the femoral ring, denuding the trunk

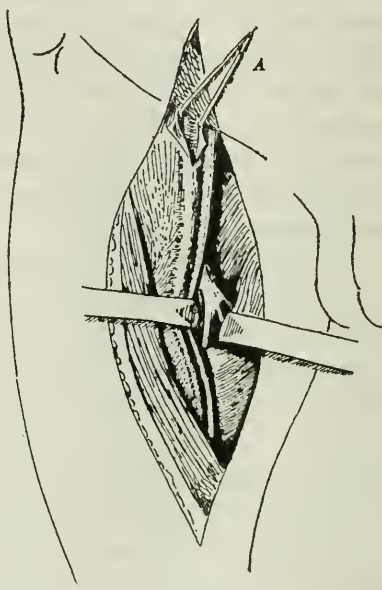
of the femoral, a ligature is passed under it and temporary hæmostasis secured (see Fig. 18). If the lesion is seated lower down than the apex of Scarpa's triangle the other end of the incision is lengthened so that the superficial femoral vessels are exposed. If they are not wounded the deep femoral vessels must be examined, and to do so they should be searched for behind the superficial vessels at the level

FIG. 27.



Deep femoral vessels. Incision for the verification of the superficial femoral vessels which should be first sought for at the apex of Scarpa's triangle.

FIG. 28.



Deep femoral vessels. A temporary ligature (A) on the femoral artery. Search for the upper border of the middle adductor muscle. The superficial femoral vascular bundle is retracted outwards, and underneath it the deep femoral vein is discovered, and the deep femoral artery lies to the outside of and behind it.

of the upper border of the adductor magnus in close proximity to the femur.

First, the upper border of this muscle must be verified. It is to be recalled that it extends from the angular surface of the pubis to the middle of the linea aspera. The aponeurosis should be cleanly incised in the direction of the muscular fibres and dissecting off the upper border of the incision in the aponeurosis the upper border of the adductor magnus will be found and all the more readily because

the vessels going under it can usually be seen (see Fig. 28). Then, following the upper border of the muscle at its lower external aspect, it will be found to become tendinous, and it is just here, at one or two centimetres from the femur, behind the superficial femoral vessels that the deep femoral vessels will be found at the point where, passing from the first to the second segment of their course, they enter behind the muscular plane. The *deep femoral vein* is the first vessel encountered, the artery is to the outer side of it.

Now, the deep femoral vessels can be explored in their segment extending from the upper border of the adductor magnus to the anastomosis of the deep femoral into the main trunk of the femoral vein, but above this anastomosis the deep femoral artery, satellite of the main trunk of the femoral vein for a distance of five centimetres, must also be taken into consideration. At this level the deep femoral artery is often postero-external to the superficial femoral artery, more or less concealed by the large horizontal venous layer of the quadriceps (see Fig. 24, A, and Fig. 25). The venous trunk can then be divided between two hæmostats some distance from the main trunk of the femoral vein and by rotating the hæmostat on the inner side on its axis the deep femoral artery will be exposed to view (see Fig. 29).

By following this procedure the deep femoral vessels will have been exposed in their entire first segment. If they are wounded behind the adductor magnus its fibres are to be divided vertically in front of the terminal portion of the deep femoral vessels (see Fig. 26).

II. TREATMENT OF WOUNDS OF THE FEMORO-POPLITEAL VESSELS

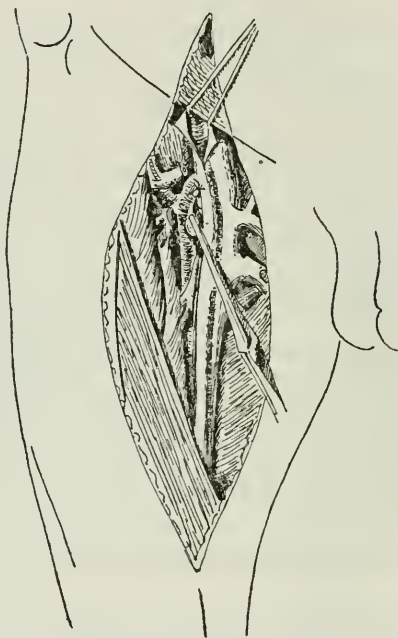
The position of the patient is most important. Fiolle and Delmas place the patient on the back as near as possible to the edge of the table. An assistant holds the leg in flexion on the thigh and brings the latter into adduction and maximum outward rotation. The surgeon must stand to the outer side of the limb and bend over above it in order to see the internal aspect of the thigh.

This inconvenient position, recommended by many writers, should be given up. The surgeon should stand on the inner side of the limb facing the region to be explored; hence, the necessity of maximum flexion and abduction. Flexion of the thigh on the pelvis and the leg on the thigh relaxes the vascular bundle and therefore renders exploration easier. Abduction makes the cord of the adductor tense

only at the landmark that we need to find, while external rotation exposes the entire field of operation in a horizontal plane.

It is clear that this position is better than the one usually recommended, but it makes it difficult for the operator to follow up a hæmatoma in the popliteal region, so that I think it preferable to place the patient on the same side as the lesion, slightly inclined on

FIG. 29.



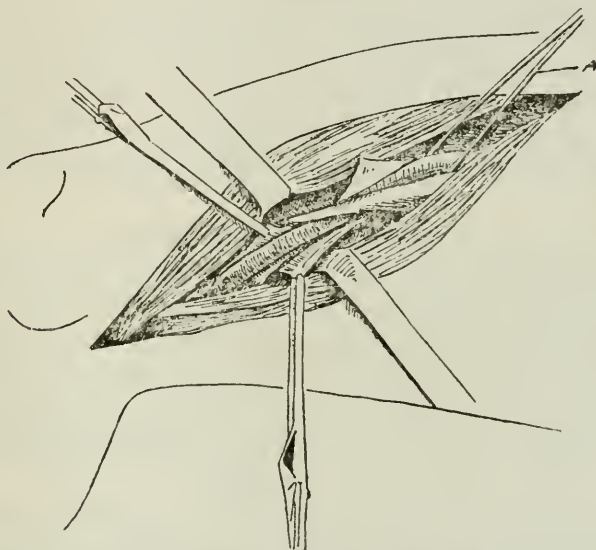
Deep femoral vessels. Division of the venous plane of the quadriceps exposing the origin of the deep femoral artery.

the abdomen, with a pillow under him to hold him in position. The wounded lower limb is placed in extension, the healthy limb in flexion—flexion of the leg on the thigh and thigh on the pelvis—in order to disengage the internal aspect of the thigh to be operated on as high up as possible.

In this position one can operate on the lower third of the femoral and upper half of the popliteal artery. Should it be necessary to work farther down, the pillow can be removed so as to turn the patient on the abdomen and thus be able to make a direct approach to the vessels by the posterior popliteal region in its entire extent.

The cord formed by the adductor minimus is felt and an incision is made which, beginning above at Hunter's canal, is directed downwards obliquely crossing the tendon of the adductor minimus and ends at the internal edge of the internal condyle. The skin and fat having been incised, the interval saphenous vein having been either ligated or retracted to the side, the aponeurosis of the sartorius muscle is incised and disengaging its posterior aspect it is retracted forwards.

FIG. 30.



Femoro-popliteal vessels. The upper retractor draws aside the sartorius, the lower, the rectus internus muscle. Between the two muscles the tendon of the third adductor is seen under which the popliteal vessels pass. A temporary silk ligature (A) is passed under the artery at the level of Hunter's canal. Two hemostats hold the edges of the vessel sheath, exposing the popliteal artery, under which the popliteal vein can be seen.

Otherwise put, the operator passes between the sartorius and rectus internus muscles (see Fig. 30).

At the level of Hunter's canal, near the exit orifice of the saphenous nerve, its accessory or the great anastomotic artery, the underlying aponeurosis is incised in front of and to the outer side of the tendon of the adductor minimus. The vascular bundle will be then exposed, the femoral artery is dissected out at the upper part of the incision and a temporary ligature applied. The artery and vein are then followed up. The great anastomotic artery must be respected, because, although often insufficient, it is the most important route for the

reestablishment of the circulation in the segment of the limb below the arterial lesion.

Then the tendon of the adductor minimus is reached and retracted to either side, but if the vascular lesion is situated just below, and if it receives muscular fibres very low down on its posterior aspect, it can be divided without trouble, but this is usually unnecessary.

WOUNDS OF THE POPLITEAL AND TIBIO-PERONEAL TRUNKS

My series of these wounds comprises thirty-one cases, as follows: Nineteen cases in the upper half, or about 60 per cent.; twelve cases in the lower half, or about 40 per cent. Like the femoral vascular bundle, the popliteal bundle is often involved in only one of its vessels—in about 50 per cent. Thus there were sixteen cases in which both vein and artery were wounded, the artery alone in six and the vein alone in nine.

In one case there was an arteriovenous aneurism in the upper half of the popliteal space; double ligature was done, and the patient discharged in good condition. In three cases there were dissimilar lesions of the popliteal artery and vein, while of the remaining twenty-seven cases, in twenty-two there was complete rupture of the vessels involved and in five there was a lateral wound. The twenty-two cases of complete rupture were: Artery and vein, twelve cases; artery only, four cases, and vein only, six cases.

The five cases of lateral wound were: Artery, two cases, and vein only, three cases, one of which was accompanied by rupture of the posterior tibials. It was a case of lateral wound of the popliteal vein, the aperture being occluded by the missile. Ligature above and below the lesion was done and the ruptured posterior tibials were ligated. Patient recovered nicely.

I have seen one case in which the hæmatoma extended very high above the vascular lesion. The missile entered in the right popliteal region and radioscopy showed that it was lodged in upper third of the posterior aspect of the thigh. There was a vast hæmatoma with considerable tension of the integuments. The normal depression over the course of the femoral artery was replaced by a swelling as far up as three to four fingers' breadth below the femoral ring. Twenty-four hours after the receipt of the injury an incision was made along the line of ligature of the femoral vessels to the extent of twenty-five

centimetres. A hæmatoma was exposed in the vascular sheath extending to within five centimetres of the inguinal fold. When the artery was exposed it was small and contracted, and after having been freed and a sympathectomy being done, as well as careful removal of all vestige of clot, a median popliteal incision was made. The aponeurosis was greatly distended and black, the subcutaneous fat very infiltrated. The aponeurosis was incised, the remainder of the hæmatoma was turned out and then venous blood was seen to surge from the bottom of the wound, which was arrested by digital compression.

The vein was quickly denuded and ligated at the upper edge of the popliteal muscle and then following the vessels upwards a complete rupture of the artery and vein near the ring in the adductor minimus was found. Four ligatures were applied on healthy tissue and the wounded portions excised. Towards the end of the operation the femoral artery had assumed its normal calibre. The wounds were partially drained. Patient made a good recovery.

This case is interesting, not only because the hæmatoma extended very high up, requiring an operation both on the femoral and popliteal, but also because it caused both mechanically and by reflex action a notable decrease in the calibre of the femoral artery, which was recovered from before the end of the operation. By removal of the clot and by sympathectomy the collateral circulation was assured and the vitality of the limb restored.

Muscular drainage in these cases is relatively slight, especially when the wound is seated in the upper half of the popliteal vessels. This is because the divergent muscular masses are small in size and their place is taken by tendons which offer a certain resistance to the missile.

The bones were fractured in nine cases, or about 30 per cent. Twice there was fracture of the diaphysis of the femur, necessitating primary amputation. There was one case of extra-articular perforation of the external condyle by a bullet; recovery in good condition. There were five joint fractures at the knee, with one death. In three amputation was done at once, and in one delayed amputation on account of the bad nutrition of the limb.

This last case was an open fracture of the knee-joint with rupture of the popliteal vessels. The fracture focus was cleansed and the joint closed. The popliteal vessels, which were completely ruptured in

the lower half of their course, were excised and ligated. On the next day there were some violet patches on the skin, indicating the onset of ischemic gangrene of the foot, and on the following day femoral sympathectomy was done, but the artery did not relax. Three days later there was total sloughing of the foot and leg. Amputation at the middle third of the thigh.

Therefore, of seven cases of fracture with lesions of the popliteal vessels, amputation had to be done in five, or about 70 per cent., especially when the knee-joint was involved. In spite of sympathectomy nutrition of the limb was insufficient, and this is because when the popliteal vessels are injured in fractures of the knee-joint there is usually at the same time division of the articular branches of the vessels, so that reestablishment of the collateral circulation is quite exceptional. Therefore, if there is shock, it seems to me preferable to amputate at once rather than run the risk of a long conservative operation, whose results are most uncertain.

Finally, in another case of division of the popliteal vein with fracture of the tibia in its upper third, secondary amputation had to be done.

Lesions of the nerves are usually confined to the popliteus internus and are rather rare. I have seen two cases and in both division of the nerve was incomplete.

WOUNDS OF THE TIBIO-PERONEAL VESSELS

There were ten cases of these wounds and in nine the lesion involved both artery and vein and once the vein alone. In two cases there were injuries to the posterior tibial or peroneal vein as well. In all the cases there was complete rupture of the vessels involved, sometimes accompanied by an enormous hæmatoma infiltrating the fat of the popliteal space and dissociating the internal popliteal nerve.

Fracture occurred in four cases and in two the damage was considerable to both bones of the leg, requiring primary amputation. In the other two cases only one bone was fractured, the tibia and fibula, respectively. There was only one instance of nerve injury, namely, dissociation of the internal popliteal from a hæmatoma.

I desire here to briefly refer to the gravity of wounds of the popliteal and tibio-peroneal vessels. Of the thirty-two cases of these injuries comprising thirty-one cases of wounds of the popliteal vessels

to which one instance of injury to the tibio-peroneals should be added and which necessitated ligature of both popliteal vein and artery, there were two cases of death, one from acute anæmia, the other from infection two months after lateral suture of the popliteal vein and ligature of the posterior tibial artery.

There were nine amputations; one for arthritis of the knee fifteen days after the first operation, which consisted of high ligature of one popliteal vein and four for ischemic gangrene, as follows: One after ligature of the popliteal artery in its lower half, one after ligature of both the popliteal artery and vein in their upper half and cleansing of a knee-joint fracture, and two after ligature of the popliteal artery and vein in their lower half for wounds of these vessels or for high-seated injuries of the tibio-peroneal trunks. In the remaining twenty-one cases recovery took place.

Such are the data of a general order that are furnished by these figures, but it is more interesting to study these cases from the viewpoint of wounds of the popliteal artery only or of wounds of this vessel accompanied by an injury to its vein. Of the thirty-two cases, twenty-two presented a lesion of the artery alone or with its vein, and to these those cases should be added in which the tibio-peroneal trunks were divided, ligature of the popliteal artery and vein had to be done. Hence, a total of twenty-three cases, of which one died from acute anæmia; four primary amputations, and four secondary amputations for ischemic gangrene. Consequently, only fourteen remain in which recovery took place, two of which after lateral suture of the artery and twelve after ligature. Otherwise put, *in 40 per cent. of the cases the patient or the involved limb died.* If we eliminate the four cases of primary amputation there remain nineteen cases, comprising fourteen recoveries after ligature and two arterial sutures, with one death after ligature and four secondary amputations after ligature.

If, now, we eliminate the two cases of arterial suture, a study can be made of the consequences of ligature of the popliteal artery, with or without its vein, in seventeen cases. There were twelve recoveries, one death and four ischemic gangrenes.

These cases show that ligature of the popliteal artery, with or without the vein, at its upper part is usually successful. In ten cases there was only one case of secondary sloughing, and this was an

instance of a knee-fracture with injury to the articular vessels which otherwise might have given a collateral circulation.

At the lower part of the popliteal artery ligature is unsuccessful in 50 per cent. of the cases. It was done twice on the artery alone, once with a successful outcome and once with secondary gangrene of the entire leg, necessitating amputation at the lower third of the thigh. Four cases of ligature of artery and vein gave two successes, one secondary gangrene of the entire leg with amputation at the lower third of the thigh and one case of gangrene limited to the foot requiring tibio-tarsal disarticulation.

From these few cases it would seem to result that simultaneous ligature of artery and vein as advised by Makins, is proper, since sloughing is not more frequent, and it may even be advantageous, since in one case the gangrene was limited in extent.

There were ten cases of wounds of the tibio-peroneal vessels, giving five amputations, three of which were primary for gas gangrene in one and fractures of both bones of the leg in two; two secondary amputations for sloughing after ligature of the tibio-peroneal artery and vein. If to these five amputations one other be added, which was done following ligature of the popliteal vessels for injury to the tibio-peroneal trunks, we have a total of six amputations out of a total of ten cases of wounds of the tibio-peroneal vessels, otherwise the formidable figure of 60 per cent.

TREATMENT

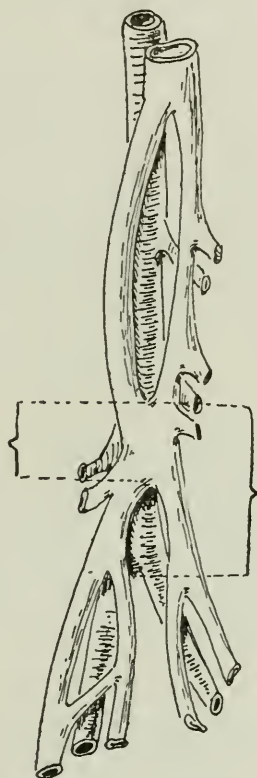
To approach the popliteal vessels an axial incision over the popliteal space should be made but carried down to the junction of the middle with the lower third of the leg, so that the tibio-peroneal trunk can be exposed, which is the origin of the anterior and posterior tibials and peroneal arteries.

At the upper portion this incision can be combined with the one I described for the femero-popliteal vessels. The following is the technic I employ: The skin and fat are incised in the axial line and the saphenous vein and external saphenous nerve are retracted inwardly. The gastrocnemius is incised at its interstice and the two portions retracted. The mid-line must be strictly maintained in order to avoid division of the vessels of this muscle. Next the internal popliteal nerve is exposed and deep down on its inner side will be

found the popliteal vein and the artery still deeper and more inwardly (see Fig. 31).

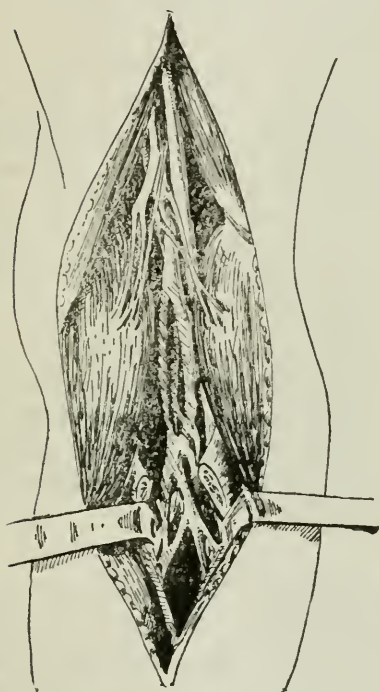
If the arch of the anterior tibial is to be dealt with or the origin of the posterior tibials or peroneals, the internal popliteal nerve, which will have become the posterior tibial nerve, should be followed and

FIG. 32.



Popliteal and tibio-peroneal trunks.

FIG. 31.



Popliteal vessels and the tibio-peroneal vessels. These are freely exposed, as well as the anterior tibial, posterior tibial and peroneal vessels. The arch of the soleus has been divided. The outer retractor retracts the posterior tibial nerve outwards.

the ring of the soleus muscle is incised opposite the nerve. By retracting the parts the popliteal and tibio-peroneal vessels are readily exposed.

A word as to the anatomy. At the upper edge of the ring of the soleus the popliteal artery bifurcates into the anterior tibial and tibio-

peroneal trunk, but while the latter continues in the direction of the popliteal artery, the anterior tibial goes horizontally forwards, passes over like an arch above the upper border of the interosseous ligament and penetrates the antero-external space of the leg. After a course of four centimetres the tibio-peroneal trunk bifurcates in its turn, giving the posterior tibial, which continues in the same direction as the peroneal artery directed obliquely downwards and outwards (see Fig. 32).

There are two posterior tibial veins—internal and external—which anastomose between themselves, on each side of the artery, and this likewise applies to the peroneal veins. The latter unite in a single short trunk, which ends in the posterior internal tibial vein. Occasionally they end separately in the posterior tibial vein. The latter vessel being thus reinforced, anastomoses one or two centimetres farther up with the external posterior tibial vein to form a single tibio-peroneal venous trunk in which the collaterals from the soleus muscle end. After a course of two to three centimetres this trunk bifurcates near the upper edge of the ring of the soleus. It is here that the arch or arches of the anterior tibial veins end. This venous confluence is drained by two trunks, which are the origins of the popliteal vein, and ascend up to the upper border of the popliteal muscle, there to form a single trunk. Otherwise put, between the upper border of the soleus and that of the popliteal there are usually *two popliteal veins*—external and internal—for a distance of five centimetres, while higher up there is but a single trunk.

WOUNDS OF THE ANTERIOR TIBIAL VESSELS

Of these I had forty-two cases, as follows: Five cases in the upper third, otherwise a little more than 10 per cent.; twenty-eight cases in the middle third, or a little less than 70 per cent., and nine cases in the lower third, or a little more than 20 per cent.

Wounds of the anterior tibials are relatively rare in the upper third of their course, because of their deep situation against the interosseous membrane and the protection offered by the skeleton and tibialis anticus muscle, which is well developed at its upper part.

Like the radial and ulnar vessels, the anterior tibials are almost always involved as a whole. A wound of the artery may be accompanied by a lesion of one of its veins. The latter send off anastomoses

between themselves over the surface of the artery, which hinders ligation, but usually the two veins are injured at the same time as the artery. It also happens, but rarely, that a vein may be injured, the artery remaining intact. This occurred in two cases. In all, the rupture was complete or nearly so.

What is characteristic of these wounds is the frequency of bone lesions, less so of the muscles. The former were met with in twenty-three out of forty-two cases, otherwise more than 50 per cent. The damage to the bones may be extensive and wounds of the vessels of the leg, like those of the forearm, are among the vascular lesions most frequently accompanied by lesions of the skeleton.

The twenty-three fracture cases were: Nine cases of complete fracture of both bones, one in the upper third, six in the middle and two at the lower third. There were four cases of fractured fibula, one incomplete at the middle third and three complete at the middle third. There was one case of fracture of the cuboid.

The nerve lesions involving the anterior tibial are usually overlooked on account of the general damage to the parts.

TREATMENT

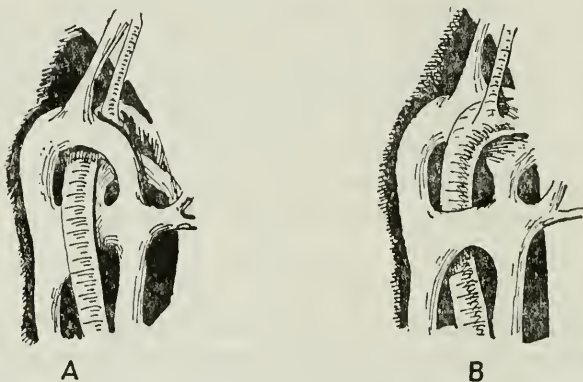
Farabeuf's incision, extending from the antepерoneal depression to the middle of the intermalleolar space is excellent and gives an easy approach to the vessels in all cases of wounds in the middle and lower third of the leg. If the injury is seated in the upper third, one should begin by finding the interstice between the tibialis anticus and the common extensor of the toes, where the two muscles are easily separated from each other. Having found it, and having exposed the vessels, the incision is lengthened upwards and the vascular bundle followed up until the lesion is found and the incision is carried up still farther in order to have plenty of working space.

The incision must be long and one need not hesitate to extend it as high up as the upper edge of the interosseous membrane or even beyond it, so that if necessary the arch of the anterior tibial can be dealt with. This arch presents three segments; the first is the segment of origin, retroskeletal and horizontal, which is comprised in a short space limited by the anterior aspect of the tibio-peroneal trunk and the upper edge of the interosseous membrane. A second intermediary segment in relation to the upper edge of this membrane and

assuring the junction with the third, or terminal segment which, bent at an angle of 90 degrees, continues with the trunk of the anterior tibial artery.

By the high incision the two latter segments can be exposed, while the retroskeletal portion can be drawn up with hæmostats and ligated. I have, however, found that the correct approach to the arch is by the posterior route. Approach to the arch of the anterior tibial artery is possible with the classic incision extended upwards. Then there is nearly always a concomitant bone lesion, while the muscular lesions must also be attended to, so that sequestrectomy and myec-

FIG. 33.



A, Anterior tibial vessels, 1st type; the venous circulation is represented by a venous arch subjacent to the arterial arch. B, Anterior tibial vessels, 2nd type: the venous blood goes to the venous tibio-peroneal trunk by way of two venous arches, respectively above and subjacent to the arterial arch.

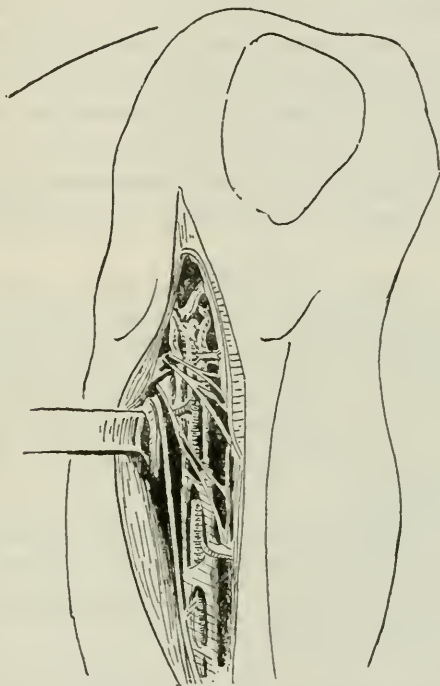
tomy having been done, the field of operation will be rendered quite extensive, excepting when the bones have not been involved.

It has appeared to me that the difficulties of hæmostasis are especially due to the arrangement of the veins, the two following types being the most frequent: In the first (see Fig. 33, A) both anterior tibial veins—external and internal—unite at one or two centimetres below the lower edge of the interosseous membrane to form an arch following the anterior aspect of the arterial arch and ending in external tibio-peroneal venous trunk. A collateral vein anastomoses with each of the tibials near their junction. These two collaterals are anastomosed by a horizontal branch, which passes in front of the arterial arch near the junction of its anterior and middle segments, so that a

venous ring lies over the arterial arch through which one has to go in order to reach the latter.

In the second type (see Fig. 33, B) the anterior tibial veins anastomose in front of and behind the arterial arch, therefore forming a ring in which the muscular collaterals and recurrent tibial vein end and through which the arterial arch must be reached. This

Fig. 34.]



Anterior tibial vessels. The arches of the tibial vessels correspond to the anterior tuberosity of the tibia. Exposed by Farabeuf's incision extended upwards four centimetres above these arches in order to obtain thorough exposure.

venous ring sends off two venous arches, one anterior, the other inferior in relation to the arch of the anterior tibial artery. They terminate separately in the external tibio-peroneal trunk on its anterior aspect.

The venous and arterial arches are in relation with the anterior tuberosity of the tibia (see Fig. 24). This is a useful landmark, because when operating in this region the horizontal portion of the arches is not visible. The recurrent anterior tibial vessels extend directly upwards and hide the anterior tibial vessels from view, and if their situation is not known the surgeon would operate at a point

too high up. As to the anterior tuberosity of the tibia, care should be taken to dissect off the anterior tibial vessels from the interosseous membrane and draw them forward, so that the vessels going to the posterior space in a horizontal direction can be seen. These are the venous and arterial arches, and they can be ligated if conditions indicate it.

Ligature of the anterior tibial artery is usually successful. However, in one case sloughing occurred on the dorsum of the foot and external aspect of the leg—the territory irrigated by this vessel. The patient had a poorly developed arterial system, and the anastomoses between the posterior and anterior tibial systems was decidedly insufficient. Amputation at the lower third of the thigh was done two days later and only one ligature on the femoral vessels was necessary, so poor was the vascular development in this subject. Recovery was complete.

Although it is exceptional that lesions of the anterior tibials alone will necessitate amputation, when associated with injury of the posterior tibials sloughing will occur, so that late amputation may be necessary. Thus it was in three other cases. Finally, amputation had to be done in a case of gangrene arising after ligature of these vessels. The muscular and bone damage may be such that primary amputation is necessary.

From a study of these cases it seems that the anterior tibial vessels are rarely the only ones involved and are usually associated with other vascular or osseous lesions requiring secondary amputation in nearly 20 per cent. of the cases.

WOUNDS OF THE POSTERIOR TIBIAL VESSELS

I have had sixty-eight cases, as follows: Seven in the upper third, or about 10 per cent., forty in the middle third, or about 60 per cent., and twenty-one in the lower third, or about 30 per cent. Therefore, wounds of the posterior tibials in their upper third are relatively rare because they are protected by the gastrocnemius and the soleus, both muscles being well developed in this region.

Forty-two of these cases were wounds of both artery and vein, a little more than 60 per cent. The twenty-six other cases—nearly 40 per cent.—were wounds of the artery only in fifteen and the veins only in eleven. Sixty-two times there was a transversal wound or

complete rupture of the vessels involved. Once only was there a lateral wound of the artery for which double ligature was done and in two cases of secondary hemorrhage occurred. Finally, there were three cases of arterial and venous thrombosis.

If there is a region where the surgeon should be attentive and where hæmostasis must be perfect, it is unquestionably the posterior aspect of the leg. A foreign body overlooked or an unrecognized lesion of the vessels will realize in a short time all the conditions favorable for the development of gas gangrene.

Fractures are common and were present in thirty-five of these cases. The nerve lesions are those of the posterior tibial and occurred in four cases, or about 6 per cent. Three were treated by suture, while in the fourth amputation was done on account of the extensive damage to the parts.

TREATMENT

A wound of the calf of the leg with probable injury to the posterior tibial vessels requires, I believe, a long median incision, and this I have invariably done, because the vessels are deeply seated in the mass of muscles and also for many other reasons which need not be detailed. It is extremely advantageous to have a general view of the vessels and in war surgery, especially, the localization of the wound is difficult to make. Injury of both vascular bundles is far from being exceptional, while a deep hæmatoma of the leg is always serious.

In all cases of vessel wounds in the two upper thirds of the posterior aspect of the leg a median incision twenty-five to thirty centimetres long should be made. The skin incised, the external saphenous nerve and vein are recognized and retracted. It is absolutely important to keep in the median line. The gastrocnemius is separated in its interstice, and the soleus is rapidly reached and then the cellular space separating the deep muscles. The approach to the vasculo-nerve bundle is announced by the hæmatoma, which separates the deep muscles from the superficial ones.

The posterior tibial nerve is the first to be seen and to its inner side are the tibial vessels, which are nicely exposed. But here again one must keep in the axis of the vessels. Now, in this region there are numerous muscular veins which are particularly friable and are the source of hemorrhage often difficult to control and several hæmo-

stats will be required, the application of which would be a loss of time, while opening them will greatly favor infection.

The first type of lesion met with in this region is when the missile becomes embedded on the inner side of the vessels. The course of the missile in these circumstances in its relation to the median incision offers two distinct segments, one external, the other internal.

To deal with the *external segment* the entrance aperture is first excised and then the wound is opened up longitudinally and the external half of this segment is cleansed. The median incision is then made which will expose the internal half of the external course of the missile.

Treatment of the internal segment is done by the median incision and leads to the projectile, which is then removed.

Let us now suppose that we have to deal with a second type of lesion, that of a seton wound crossing from without inwards the line of the vessels. The track of the missile is clean-cut. Here again two segments of the course of the missile are to be considered—the one external, the other internal. The former should be dealt with as already described, the inner segment is to be treated in a symmetrical fashion, that is to say, that for each segment the external aperture—entrance or exit—is first dealt with and then from the median incision. Such, briefly, is the treatment to be employed in all wounds of the vessels in the upper two-thirds of the leg.

When the wound is a low one, according to the case, an incision is made along the internal border of the tendo-Achilles or one made equidistant from this tendon and the internal malleolus. For the posterior as for the anterior tibial vessels, ligature is the only procedure to be employed. It is generally successful, but sometimes the damage to the muscle is such or the bone lesions so extensive, likewise the lesion of the vessels themselves, that primary or secondary amputation will become necessary. Infection is particularly favored in the posterior portion of the leg, which is an area of predilection for gas gangrene.

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